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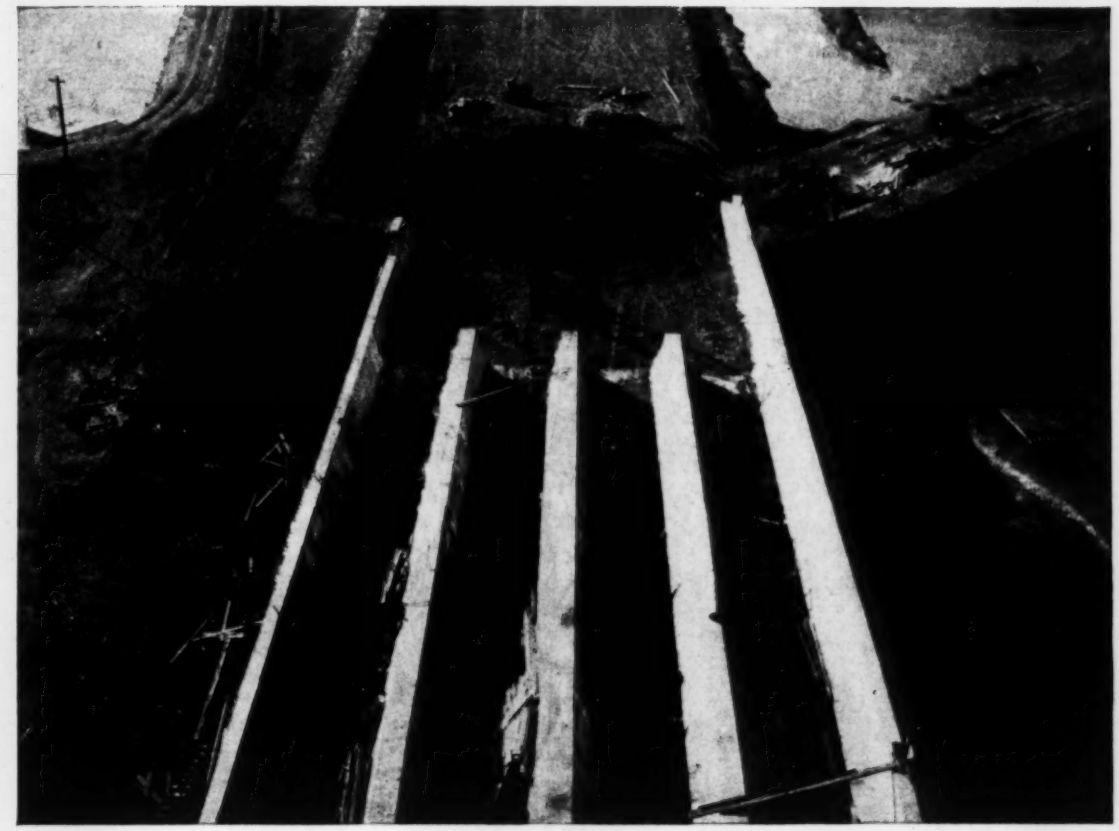

Trough-Shaped Railroad Bridge at Pueblo

September 10, 1925

Trough-Shaped Concrete Bridge Resists Flotation

Continuous CO Recorders in Liberty Tunnels

Repair of Concrete Road Blow-Ups in Delaware

Determination of Kutter's *n* in 15-in. and 18-in. Pipe

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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

FRANK C. WIGHT
Editor

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Engineers and The Income Tax Lists

THE current publication of income tax payments pits a man's judgment against his curiosity. Few can be found who defend this invasion of time-honored privacy, but few can resist scanning the lengthy lists the newspapers are spending so much money to print. Engineers, being human, are not immune from this curiosity, so they cannot have avoided seeing how the published lists confirm the fact, too well known to them already, that engineering is not a profitable vocation. Most of the lists contain the names only of the fortunate minority whose tax rises above the average, and how rare does one find a name listed in the engineering society annuals. The local butchers are there and the bankers, of course, and most of the so-called business men, with a scattering of the better known lawyers and doctors, but when an engineer's name does appear he generally is one of those who some time since forsook the pleasant paths of professional endeavor to take financial risk or to sell some one something he did not altogether want, or wanting was not altogether sure from whom he should buy. The major income from practicing engineering continues to be the psychic one the books on economics talk so much about. Fortunately for the world, that so needs the engineer, that kind of income is one of the most satisfying.

Honoring Pioneer Engineering

THERE are no frontiers left in the United States. Only here and there can we find an engineer who has had the adventure of pure reconnaissance, the seeking out of proper line and grade through virgin ground, unmapped and unexplored. That particular thrill of engineering the present generation can never know, unless they go to the outways of the earth, there to repeat the development that the last half of the last century saw on this continent. It is a good thing, though, to have the present engineering generation reminded of what its immediate predecessor contributed to the opening of the Great West, that was a frontier so short a time ago. So the graceful act of the Great Northern Ry. in placing a statue of John F. Stevens on the Pass that he discovered should be appreciated by every engineer, not only as honoring one whose pioneer engineering has now reached the full flower of performance but as a recognition of the profession whose pioneering is too often overshadowed by the more spectacular excursions of the prospector, the gun fighter and the financial adventurer.

Pavement Blowups

AN INTERESTING experience is being had in Delaware with expansion "blowups" of concrete roads. The details are given in this issue. They show that equipment for and a neat technique in making repairs have been developed. Plainly Delaware is handling its interesting maintenance problem altogether skillfully, but why, as appears to be true, are Delaware concrete roads blowing up oftener than they are in most states? Some of them, but not all, have sand subgrades. They are flat, they have long tangents, the climate is warm, but all these conditions can be found elsewhere. Delaware is building a narrower pavement than are most states, but its design, materials, and construction suffer nothing in a comparison with practice elsewhere. If its pavements are popping oftener, what is the reason?

Municipal Home Rule Upheld

THE unanimous decision of the New York State Court of Appeals reversing the equally united action of the Appellate Division and justifying the trial court's validation of the constitutional amendment giving home rule to the municipalities of New York State is in large measure a rebuke to all strict constructionists who from duty or inclination give minute and conflicting technicalities the benefit of the doubt and thus defeat the unquestioned will of both legislators and the public. Although the litigation has no relation whatever to either the merits or constitutionality of home rule in itself the final decision will undoubtedly aid the progress of the municipal home rule movement in those parts of the country—and they are extensive—where the cities and towns have to go to their legislatures for every charter change they may desire, no matter how minor. Aside from the direct good of home rule to the municipalities it benefits them and the entire body politic by relieving the legislatures of a mass of local legislation involving no questions of state-wide interest and thus giving more time for fundamental questions of state policy.

Restricted Immigration and Labor Rates

REPORTS for the fiscal year which ended last June show that the new immigration law is serving its purpose of keeping down newcomers, at least in so far as the legal entries to the country are concerned. The total number of aliens coming here for this year was 294,314 or 32 per cent of what it was the year before, itself a restricted year as compared to pre-war immigration. Further than that, the emigration of the nationals of European continental countries has been very large so that our gross increase of population from outside the country comes largely from Canada and Mexico. This in itself is not disturbing, for our two neighbors send helpful citizens as a rule and ones who will fit into our labor needs, but it is disturbing to know that our ranks of labor are not being increased as they should be to take care of the normal increase of work for labor to do. It is too soon to judge whether the fear of too great immigration justifies the cutting down of our labor supply but it is not too soon to realize that with that supply cut there is small chance of there being any reduction in the wage that the remainder with draw.

How To Plan District Water Supplies

CLEMENS HERSCHEL'S sound plan for meeting the water-supply problems of the New Jersey Metropolitan District should be considered in every state and section that has either water or sewerage problems that require the creation of districts for their proper solution.

Mr. Herschel does not mince words in characterizing the commission created many years ago to deal with the Passaic Valley sewerage problem, and copied largely in the North Jersey Water District Act, as "the agent" of a "loose, riotous and recalcitrant partnership," which has taken thrice the time and at least twice the money necessary for the sewage-works it has built. This he blames not on the sewage commission but rather on its circumscribed powers. By inference, Mr. Herschel believes the water commission will prove to be much the same sort of an agent since it is serving the same kind of partnership.

With forcefulness Mr. Herschel presents the fundamental reasons why the New Jersey Legislature set up such cumbersome and loose-jointed machinery to provide the New Jersey Metropolitan District with joint sewerage and water facilities. These reasons were a constitutional barrier against state bond issues and attempts to get around the barrier by legislative expedients which ignored sound engineering, economic and governmental principles. Brevity excluded from Mr. Herschel's statement the facts that the Act of 1902 creating the Passaic Valley Sewerage District and Commission provided for district bonds instead of the later and present plan of bonds issued by the several communities, but that in 1905 that act was declared unconstitutional because it forced communities, willy nilly, into a district and imposed taxation without representation in a legally constituted unit of government. So in 1907 an agency-and-partnership plan was evolved, which has proved to be exceedingly cumbersome and time consuming, for besides requiring separate governmental action and signature to the original contract by each municipality a supplementary contract with a like series of actions is necessary whenever a new partner is added or any change made in the basic or amended partnership. In both sewage and water districts there have been repeated delays and beginnings anew because of the partnership agreement feature.

These cumbersome conditions have arisen not merely because of the partnership arrangement but also because of the basis for allocating costs. Each partner in both the sewerage and water districts is assigned at the outset a definite part of the daily capacity of the works in question, since the district commission's capital fund comes from the contributions to that fund by the several communities. In the sewerage district partnership, although each partner has a right to a definite part of the capacity of the trunk sewer the allocation of first costs is prorated not on assigned capacities but on assessed valuations *of 1907*. This results in wide divergencies in costs per unit of capacity allotment, the most extreme of which is afforded by East Orange and North Arlington, the former paying 39 times as much per unit of capacity allotment as the latter. Such disparities are avoided in the water scheme, but not the capacity allotments with their consequent necessity for endless suplementary agreements.

In comparison, Mr. Herschel's plan is simplicity itself. Since the state provides all the capital, there is a yearly assessment by the state authorities of each community's share of capital, maintenance and operating charges, based directly and solely on its water consumption for the year.

Forty years ago New Jersey had a State Water Supply Commission. It proposed state development of public water supplies, particularly in this very district. The commission died in infancy through lack of public support and presumably the opposition of private interests then planning to supply not only the New Jersey but also the New York Metropolitan Districts. Since the '80's large increases in population and water consumption, and also higher standards of quality have caused many changes in the details of the water problem of Metropolitan New Jersey, but the main problem has merely been enlarged: How to insure water in ample quantity and safe quality for communities so closely massed and so pressing upon each other and upon adjacent sources of water supply that acting singly they are well nigh helpless. These and similar problems as to sewage disposal in Northeastern New Jersey have never been squarely faced by the public nor adequately solved by their representatives.

It is time to stop loading all the blame on the New Jersey Constitution. That bugaboo was raised at least 30 years ago, when resolutions of the first meeting to devise a remedy for Passaic River pollution, contemplating a sewerage district financed, in the first instance, by state bonds, was set aside because of a constitutional prohibition against a state bonded indebtedness of more than $100,000 without approval on referendum. No referendum was ever invoked on either sewerage or water supply and no attempt was ever made to remove the constitutional barrier by amendment. It has been urged that an amendment takes two or three years. It has been ten times three years since the movement for the Passaic Sewerage District was started (1895) and it was a dozen years before a sewerage district that met constitutional requirements was created.

Mr. Herschel shows, first by the constitution itself, then by citing action under it, that with a public will to do state funds for large improvements can be had. For the existing weak agency of a loose partnership, liable at any time to become "recalcitrant" if not "riotous," Mr. Herschel proposes a small strong competent commission, backed by the powers and finances of the state—just as was the intent thirty years ago of those who took the initial action for the Passaic Sewerage District and was recommended forty years ago by the then existing State Water Supply Commission, and as was recently suggested by Allen Hazen in his report on the Future Water Supply of New Jersey.

The engineers of New Jersey should unite in backing the dean of their profession in his effort to arouse public support for a plan which if adopted decades ago would have saved the people of northeastern New Jersey untold millions of water and sewerage expenditures, a plan which is needed far more than ever today in order to insure an adequate and safe water supply at reasonable cost to one of the most important metropolitan areas in the world. More than that, the principles involved should be recognized by engineers generally, for as time goes on the formation of such districts will become more and more necessary.

A Tragedy of Over-Confidence?

"IT WOULD appear to be folly," wrote the designers of the U. S. Navy dirigible *Shenandoah* nearly two years ago, "to enter a thunderstorm cloud with large, fully developed cumulus tops and subject the ship to the unknown dangers of wind, rain, hail and lightning." Last Thursday morning, Sept. 3, at 5 o'clock, the *Shenandoah* fell to the ground a broken wreck while trying to fight its way through the heart of a violent thunderstorm. Event could not verify prediction more accurately—nor more terribly, if we think of the officers and men who fell to death with the ship.

In two years of successful flight, the *Shenandoah* had created for itself a seemingly limitless confidence within the naval administration. Justified by the spectacular first performance of the ship, when storm winds tore it loose from its mast at Lakehurst and wrenched the forward part of its framework to pieces without destroying its ability to fly and maneuver, this confidence could not fail to increase in the subsequent service. In the background, however, there was at all times the knowledge of its designers that the *Shenandoah* was a delicate craft, that various weather conditions, by no means abnormal, might destroy it, and that even more ordinary conditions subjected its frame to stresses so high that only a small factor of safety was left, a margin much lower than the engineer in civil practice likes to think of. A splendid fair-weather ship, the *Shenandoah* was not fit to face every storm.

The designers had given warning that the vessel "should be operated with due consideration for the weather." But such warning, the more so when expressed in the far-off quiet of a foreign technical society's meeting, could easily remain unnoticed, or if noticed be forgotten, under the stronger impressions of growing confidence derived from the ship's service. In this confidence, we may judge, the cruise of the *Shenandoah* to the Middle West was ordered, and in this confidence, while crossing the rough hill country of eastern Ohio, it ran into the storm which destroyed it. Was the tragedy the result of over-confidence?

At present the detail events of the disaster are still a mystery, and they may remain so. It is quite possible that the scattered wreckage will not reveal information sufficient to piece together the story of the failure. Facts have been alleged, moreover, that suggest the possible existence of danger elements not present in the original construction, or weaknesses in exterior details whose failure nevertheless brought about the failure of the hull. It is stated that eight of the sixteen or twenty gas safety valves were removed some time ago to minimize the loss of helium in the normal rise and fall of the ship, and that this change created the danger that some of the gas cells might burst in a sudden rise. A new water-recovery system recently installed is said to have changed the weight distribution, producing a greater concentration of load at one point than was originally intended; and in addition some of the frames are said to have been cut and respliced in making the change. Accounts of survivors, as gathered by newspaper reporters, suggest that the motor and control cars suspended from the ship may have torn away first, wrecking the main structure by the damage done in their tearing loose; and, again, that fuel tanks tore out of their guides and then smashed through the main members of the ship's frame. The inquiries into the diasaster may throw light on these points and give them their due importance. But they are not likely to change the fact of the ship's unfitness for unrestricted air cruising and of the apparent absence of forethought as to weather conditions in the forward course of the *Shenandoah* on its fatal cruise. The conjunction of these facts points much towards over-confidence.

Navies are fighting machines, and the *Shenandoah* was built as a fighting unit of such a machine. Efficiency must take precedence over security in constructions of this kind, and failures from insufficient safety margins may therefore be anticipated. The civilian engineer has little direct concern in such failures. The *Shenandoah's* end, on the other hand, concerns him closely and intimately. Here was a fabric of the structural engineer's own forms, designed and built with his processes, and the ship in its lamentable destruction seems almost like a huge bridge that has fallen. Accordingly, the civil engineer asks anxiously why it fell. If weaknesses of structure chargeable not to inadequate assumptions of the designers but to faulty action of the members of the frame were involved, he asks that the facts be made known to him as soon as determined. If the strength of the large, paper-thin duralumin struts of the frame was less than had been concluded from the tests, if the steel bracing wires with their wire-served loop ends pulled out, or if the analysis of the frame under known forces failed to account for all the stresses that might contribute to failure, the facts will have immediate bearing on structural knowledge. In this respect the story of the *Shenandoah's* destruction is of immediate importance to the development of civil engineering science.

Dominating all other facts of the case is the unknown hazard of the air. The designers themselves expressed this clearly—and with a respectful fear pervading their words. The commander of the ship expressed it in forebodings concerning the weather risks that might be encountered in the very region where the ship fell —his native region, it happens. The accounts of survivors and eye-witnesses of the wreck, telling of strange, sudden upshootings and drops, the ship sometimes standing on end, point to the existence of wind actions and forces of which we have no knowledge and for which we can make no sure calculations. Clearly, the air hazard is like that of the sea; and the sea has been explored and sailed over for untold centuries, while the air was first invaded by man two decades ago. Before the air is thoroughly explored and its dangers better known, many more disasters may likely happen; and whether charged to incomplete knowledge or premature confidence, they will in truth be merely part of the price that must be paid for venturing into the unknown.

In the end, however, it is plain that the present tragedy will contribute to the progress of air navigation, and will make the future of the dirigible more secure. As every structural failure gives us a closer definition of the limits of resistance and attack, it furnishes a guide line of safety for better work thereafter. The *Shenandoah* itself is now nothing but scrap metal and tatters; but from its wreck there will be salvaged better knowledge. And a part of that better knowledge may come from a frank explanation by the Navy of the things it learned that led it to disregard the plain warning of the designers of the ship.

Trough-Shaped Concrete Bridge Resists Flotation

Deck Tied to Flexible Concrete Piers Adds Weight and Eliminates Necessity of Providing Rollers in Pueblo Bridge

By C. A. Bock
Secretary, Dayton Morgan Engineering Co., Dayton, Ohio

THE MAIN feature of the Pueblo (Colo.) flood control project is the relocated new river channel through the city. Increased capacity is secured in this channel by locating one side along the foot of a bluff and by building along the other side a levee which rises 15 ft. above the valley floor. The design of this new waterway places the flow line of an extreme flood several feet above the ground surface at the mouth of Dry Creek, a tributary entering the Arkansas River just above Pueblo, and requires a short levee on each side of Dry Creek to prevent backwater from entering the city through this stream. The top of these levees is 9½ ft. above rail at the point where the Atchison, Topeka & Santa Fé R.R. and the new tracks of the Denver & Rio Grande Western R.R. enter Pueblo from the west. The flow line of a flood like that of 1921 would be 4 ft. above rail.

Since these tracks lead to the west end of the new Denver & Rio Grande Western yards immediately east of Dry Creek it was not feasible to raise the grade for crossing the creek. In order to overcome this difficulty the tracks were carried over the creek through a concrete bridge having a trough-shaped span for each track, with a solid concrete floor and sides of solid concrete rising 8 ft. above the track level to join the levees at each end of the bridge, Fig. 1. This railway bridge is a four-track, five-span continuous girder structure, 200 ft. long. The 40-ft. spans are supported by flexible concrete piers which are connected with the girders to assist in preventing flotation. Other features of the bridge include cantilever shelves on the back of the abutments to gain the weight of the earth on the shelves, erection of all formwork at once to save time, jacks to maintain constant levels in the falsework during deposition of concrete and protection of winter work.

With the river in high flood the tendency of the bridge to float would be great and concrete was selected as being the most suitable material to afford an economical design that would meet the requirements of the situation. By making the piers integral with the girders their weight could be added to that of the spans to resist this tendency to float. Thus the five spans are tied firmly together with the piers and form a continuous solid mass of concrete 200 ft. long. In order to make proper provision for contraction and expansion of this 200-ft. mass of concrete each end was set on zinc bearing plates on the abutments. These plates are 3 ft. wide and extend the full width of the bridge floor. The upper plates are ⅜ in. thick, and the ones on which they rest are ⅝ in. thick.

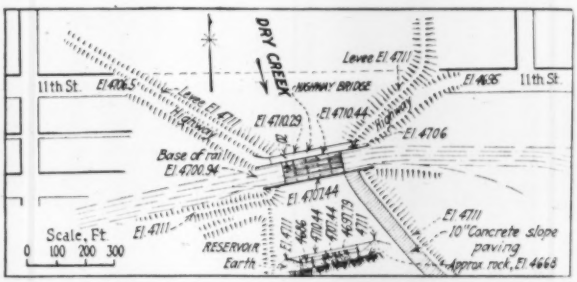


FIG. 1—LOCATION OF BRIDGE SHOWING LEVEES

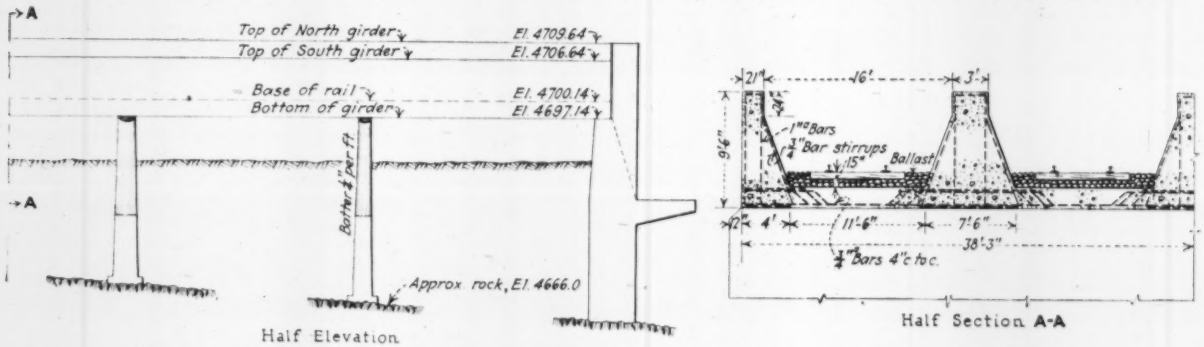


FIG. 2—SECTIONS OF DRY CREEK BRIDGE, PUEBLO

The deck consists of four troughs through which the tracks run. These troughs are formed to fit the clearance diagram required by the railway. The triangular enlargement of the girders between the tracks at the bottom is uneconomical of concrete from the standpoint of the strength of the main girders, but is required to resist shear; the extra concrete gives additional weight to prevent floating and it also decreases the length of span of the floor slab. The upstream girder is 12½ ft. high, 3 ft. higher, Fig. 7, than the others to allow for heading-up of water on the upstream side of the bridge. This gives the bridge a capacity of 45,000 sec.-ft. from Dry Creek when the Arkansas River is in flood.

The bridge was designed for an E-70 loading and 98 per cent impact, as determined by the A.R.E.A. impact formula. This loading required heavy reinforcement in the girders and floor system, Figs. 3 and 4. In all, about 250,000 lb. of steel was required in the girders and floor. The main rods of the girders are 1 in. square and those of the floor ¾ in. square. Since close planning was necessary to place the girder rods

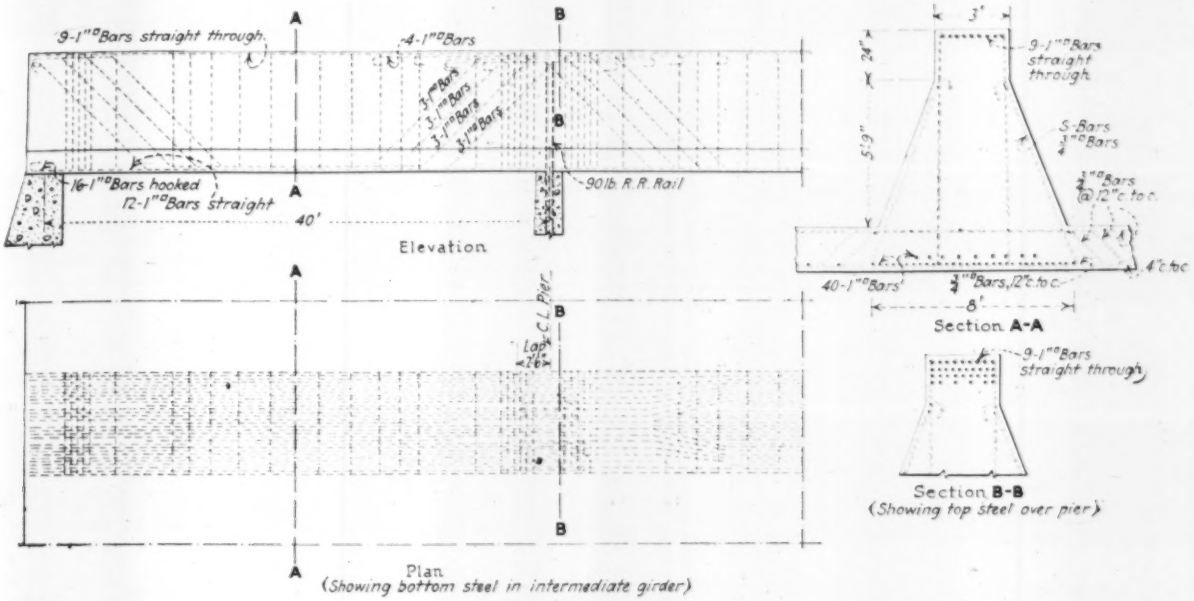


FIG. 3—DETAILS OF REINFORCED-CONCRETE GIRDERS FORMING TROUGH BRIDGE

without interference the exact position of each rod was shown on the drawings, and the steel was ordered from the local mill cut to exact length, some of the longer bars of the girders being over 70 ft. long.

One of the features of the bridge was the design of

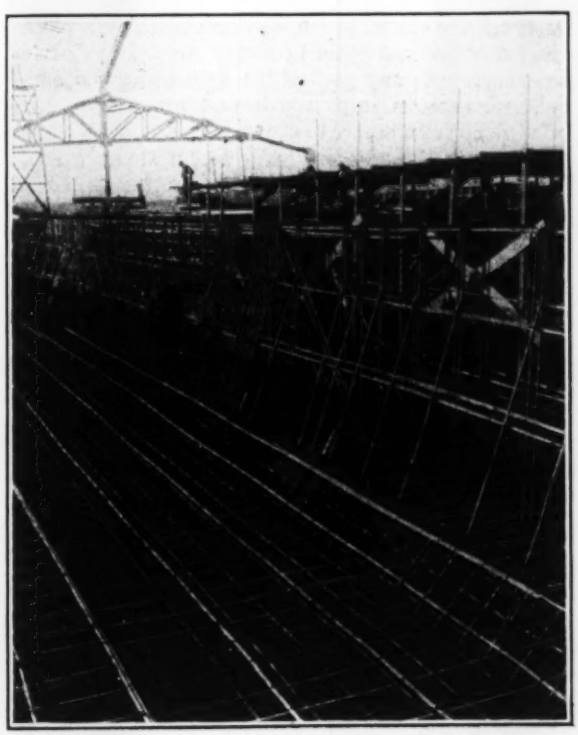


FIG. 4—STEEL IN FORMS OF FLOOR AND GIRDERS WAS ALL PLACED BEFORE CONCRETING STARTED

the four flexible piers, Fig. 6, built integral with the girders. Because of the great weight necessary to resist floating the expense of providing suitable rollers on top of the piers would have been excessive, and to make the piers heavy enough to resist overturning with sliding contacts, such as were adoped for the abutments, would have required a large mass of concrete. In either case the weight of the piers would not have been available to resist flotation. The piers were therefore made flexible, rigidly attached by railroad rails embedded in the concrete to the bottom of the girders and floor at the top and resting on bed rock at the bottom. The piers nearest the center, where the expansion movement is least, are made 3 ft. thick at the top, while those nearest the ends where the expansion movement is greater are 2 ft. thick. The thickness of these piers at the bottom is 4 ft. 3 in. and 5 ft. 3 in. respectively. The piers are reinforced on both sides with ¾-in. square rods spaced on 4-in. centers, to take the tension induced by the bending.

The abutments used on the Dry Creek bridge are of an unusual type which it is believed will find wider use in future construction. As it was necessary in the design to satisfy both the engineers of the district and those of the interested railways, the wide variation of ideas held by engineers regarding the correct method of designing retaining walls was brought out, and also how little is really known about the pressures and passive resistance of earth. The design adopted consisted of rectangular concrete piers from rock up to the ground line. At this point a horizontal cantilever shelf projection was added on the back side of the abutment to utilize the weight of the earth fill above it to increase the stability. This provision permits the use of an abutment, extended down to rock, with a much smaller volume than would be necessary with a plain gravity section.

The abutments were sunk to rock by means of excavation in open concrete caissons by the method described in *Engineering News-Record*, Dec. 4, 1924, p. 903. The greater part of the excavation for the piers was made by a dragline excavator, the entire area beneath the bridge being uncovered to 6 ft. above rock, and the earth used in the nearby levees. The remaining 6 ft. of excavation was made by an individual cofferdam for each pier, excavated by hand.

Concreting—The first lift of the piers and the caisson sections of the abutments were poured with a

small mixer located near the structure. The remainder of the bridge was poured from a central mixing plant with tower distribution, Fig. 5. The aggregate was brought to the plant by railroad, and dumped into a bin from which it was hoisted to the screening plant and thence dropped by gravity into the stone and sand bins. From these bins it fed by gravity to measuring hoppers and thence by gravity to the mixer. The cement was placed directly in the ½-yd. motor-driven mixer from the sacks.

Steel was bent on the job. The form for the bottom of the deck slab was erected first and the bending was done on this floor. On account of the large size of

FIG. 5—PLACING CONCRETE ON DRY CREEK BRIDGE FROM SINGLE TOWER AND CHUTE

Tower, extending 126 ft. above bridge floor, discharged through permanent chute on center line of bridge. A distribution truss was pivoted on falsework and could swing to cover any part of span being poured.

the bars and the large number bent to the same dimensions, the work was economically done in this manner.

Because of the great weight of the massive girders, very heavy falsework was required. Since it was necessary to rush this bridge to completion in order to enable the flood-prevention project to be completed a year ahead of the original schedule, falsework for the entire bridge was set at one time. Railroad ties, available from the railroad construction features of the project, were used to a large extent for mudsills and shores. Where ties were of insufficient length 6x6 and 8x8-in. timbers were used. The space around the piers and abutments was backfilled with earth and gravel in order to reduce the amount of falsework required to support the deck forms. On account of the settlement to be expected from the enormous weight of concrete, it was necessary to provide means of holding the deck forms in place. Pine wedges were placed at the top of each post and jacks were used to share the load when driving the wedges. In this way reference points attached to the floor joists of the forms were held to their original elevations while the concrete was being poured. The method proved entirely satisfactory. Sectional forms were used for the sides of the girders. As the adjacent half floor span was poured at the same time as the girder, it was necessary to hold these forms above the form for the bottom of the floor slab. This was done by means of 1-in. bolts extending through the floor slab in pipe sleeves, these sleeves being left in the completed bridge for drainage.

From the mixer the concrete was hoisted to the top

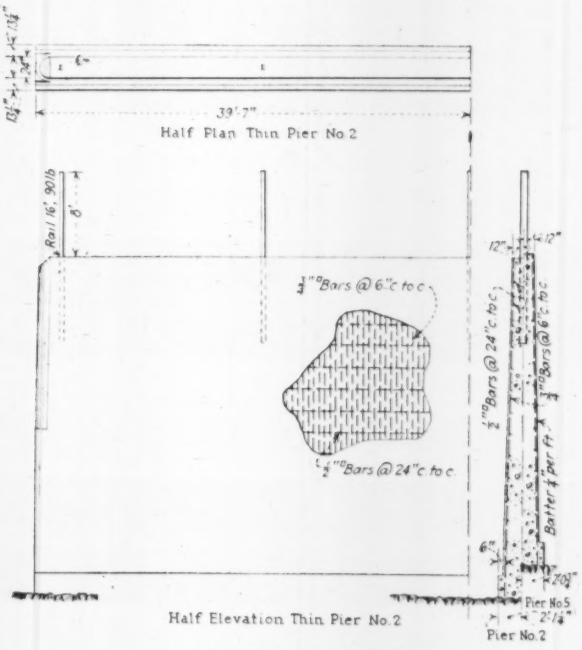


FIG. 6—DETAILS OF PIERS

of the distribution tower, which extended 126 ft. above the floor of the bridge. From the top of the tower it flowed through a chute extending longitudinally along the centerline of the bridge to a distribution truss carrying the chute, which was supported by a pivot on the falsework and could be swung around to distribute the concrete to any part of the span being poured.

The concrete was poured in sections, a 40-ft. length of girder (from center to center of span), with the floor half way to the adjacent girders comprising a section.

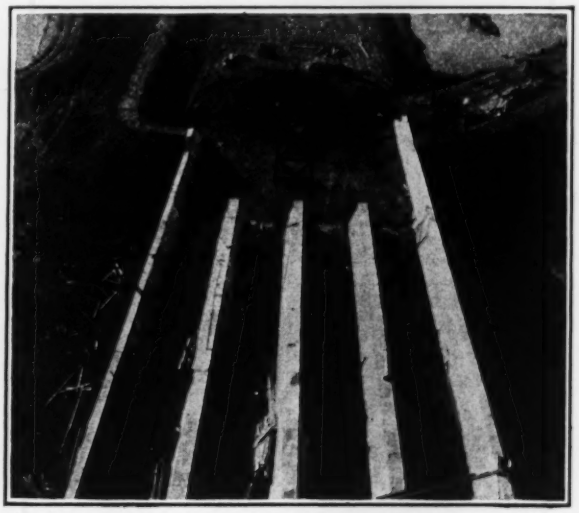


FIG. 7—COMPLETED FOUR-TRACK BRIDGE FROM CONCRETE TOWER

Upstream girder at right is 2 ft. higher than others to allow for heading-up of water.

The sections contained about 150 cu.yd. each and were poured continuously, about 8 to 9 hours being required.

On account of the urgency of completion some of the work was carried on in freezing weather. Mixing water was heated in a steam boiler. The bridge was

enclosed by roofing over the top with planks and covering the falsework with burlap. Salamanders were burned in the enclosure during low temperature periods.

At the time the bridge was designed provision was made to support one side of a highway bridge, which would replace an old wooden bridge. This bridge has now been constructed by the city of Pueblo. It is supported on one side by the railroad bridge and on the other by cylindrical piers of concrete carried to bedrock. It consists of five main spans opposite corresponding spans of the railroad bridge and two approach spans, all of reinforced concrete, beam and slab construction, with a roadway width of 20 feet.

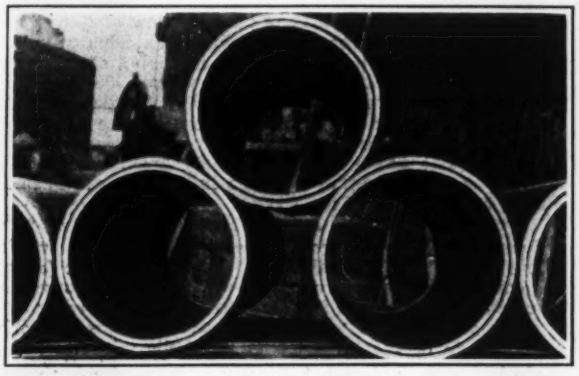
The railroad bridge was designed and built under the direction of the Dayton Morgan Engineering Co., chief engineer for the Pueblo Conservancy District. Barton M. Jones has local charge of the project.

Use of Burned Clay, Concrete and Wood Pipe For Irrigation

Some of the Clay and Concrete Pipe Without Bells and With Mortar Joints and Collars—Internal Expanding Forms

By R. K. Tiffany
Consulting Irrigation Engineer, Spokane, Wash.

THE recently completed irrigation system of the Spokane Valley Irrigation District embodies some construction features that are believed to be novel. The project itself is different from the ordinary irrigation project in that the land served lies almost at the city limits of Spokane, a railroad jobbing and manufacturing town of 110,000 people. The project is traversed by two paved highways, three transcontinental railway lines, and an interurban electric line. A cement mill and a clay products factory are located upon the project, and there are almost unlimited quantities of excellent sand and gravel.



BONDING-JOINT GROOVES
Used in bell-less vitrified clay pipe in irrigation project.

The main canal within the district is entirely lined with concrete. The distribution system consists wholly of pipe lines, concrete and vitrified clay being used for heads of 25 ft. and creosoted woodstave pipe for greater heads. In some of the smaller ditches vitrified clay or concrete liners consisting of half pipes have been used.

The concrete pipe, where used, was of the ordinary bell-and-spigot type, except that for some low-head lines thin-shelled pipe with butt joints was used.

Several miles of vitrified clay pressure pipes were laid, using first the ordinary sewer pipe and later a bell-less vitrified clay pipe, which proved to be very satisfactory. This pipe, which was made in 8- to 18-in. size, was cylindrical throughout its length, the ends being scored on the outside for bonding of the collar, each end of the pipe carrying an annular groove about ¼ in. deep, as shown in the view. At first some difficulty was experienced in laying this pipe, but a method was finally evolved which speeded up the work and cut the cost of laying from 10 to 20 per cent below that of laying the bell joint pipe.

INTERNAL EXPANDING FORM
This form used in aligning vitrified clay irrigation pipe and making smooth interior joint.

An internal expanding form was used to secure alignment and make a smooth inside joint. The trench was prepared without excavation for collars as required with ordinary bell pipe. As a length of pipe was laid a small place under the end was hollowed out and in this a bed of mortar was placed on which the end of the following joint rested. The new section was laid about ¾ in. from the preceding one, and this open joint was filled by hand with mortar. The last joint was then shoved toward the completed line, squeezing the mortar thoroughly into the annular grooves and completely filling the joint. The newly laid section was then thoroughly bedded by tamping earth up to the quarter point and another section laid. A finisher followed close behind and added a collar of cement mortar about ¾ in. thick at the joint, feathering out 3 in. each way. Some sections laid without this collar and tested under 12-ft. pressure showed that the collar may be omitted.

The advantages of this kind of pipe are apparent. The cost of manufacture is reduced approximately 15 per cent on account of the saving in labor and material as compared with the bell pipe, and the increased kiln capacity due to leaving off the bells. There is a similar saving due to the fact that a narrower trench may be used, no excavation is necessary for bells, and the pipe may be laid more rapidly than the bell type. The reduced weight and closer piling materially reduce transportation charges. There is also a saving in the amount of material required for joints, and on the whole our experience indicates that with ordinary care in laying a better job is secured, with less leakage, by use of the bell-less pipe than with the ordinary sewer pipe. It should be useful for any purpose for which clay pipe is adapted.

Concrete Jacketed Piles on the Pacific Coast

Comparison of Structural Capacity and Difficulties of Erecting Different Types of Protection Against Marine Borers

By Frank G. White
Chief Engineer, Board of State Harbor Commissioners, San Francisco, Calif.

From a paper presented by Mr. White at the meeting of the Pacific Coast Association of Port Authorities in San Francisco June 18 to 20, 1925.

CONCRETE coverings for the protection of wooden piling have been extensively used in waters infested by marine borers. This paper discusses the various types of jacketed piles which have been used most extensively and presents some evidence as to the relative merits of the different types.

Concrete pile jackets may be divided into two general classes; one in which the jacket is cast in place over a previously driven pile and the other in which the covering is applied to and driven with the pile or is cast on shore and after curing is set in place over the pile. A number of different types have been evolved under each of these two classes but only a limited number have been used extensively.

Cast-In-Place Jackets—The use of concrete deposited around wooden piling as a protection against marine borers has been common practice for many years. Where the bottom is bare at low tide or where the water is comparatively shallow, good results are easily obtained if reasonable care is taken to maintain tight forms so as to exclude water during concreting. As the depth of water increases, however, the problem of depositing concrete so as to provide a relatively thin shell which will be sound and durable and of properly reinforcing this shell, becomes increasingly difficult. Numerous special forms and attachments have been devised for the exclusion of water and mud during construction. They have been of two general types, one based on the use of full length forms and the other in which sectional forms were used.

Both steel and wood have been used for the construction of full length forms. They were made long enough to extend from the under side of the deck to a sufficient depth below the mud line to give the necessary protection and were left permanently in position. In the work done in San Francisco the steel forms were riveted pipes made of $\frac{3}{16}$-in. plates and of sufficient size to enclose a cluster of three piles. The wooden forms were ordinary wood stave pipe and were of various sizes enclosing from one to three piles. Apparently in the earlier construction of this type the necessity of penetrating the bottom to a sufficient depth and of excluding the mud and water during concreting was not fully realized or else sufficient care was not taken to insure proper workmanship. In fact the very nature of the work made it difficult to secure satisfactory results. On account of the restricted space in which to deposit concrete and the depth below the surface, proper compacting was not always secured, the result being the formation of voids. Frequently the forms were not pumped dry and the result was poor concrete or laitance streaks, particularly near the bottom.

In general it may be said that the pile casings in which steel forms were used have given good service while those constructed with wooden forms have not been a success. In 1895 several hundred piles were jacketed with concrete deposited within steel forms. The majority of these are still in service although a number have been replaced due to the failure of both the steel shell and the concrete. In many of those which remain the concrete was evidently of an inferior quality and has disintegrated, the protection being furnished by the steel form.

From 1903 to 1906 several piers were built in which more than 3,000 pile jackets constructed within wooden forms were used. Commencing in 1912 extensive replacement was begun and at the present time less than 500 remain in service. In 1910 one pier was constructed in which a special shoe with a rope gasket was used on the bottom of the wood stave forms to exclude the mud and water. Apparently great care was taken to secure good workmanship, with the result that of the 770 piles which were used, none have been replaced and only 17 have had minor repairs.

Forms built in sections of such length that they can be handled below the deck of an existing structure and above the water level have been used principally for constructing concrete jackets around piles which have been attacked by marine borers, and this type of construction furnishes a practical method of making such repairs without replacing the piles. Where steel forms were used the bottom section was constructed with a series of spring plates to keep the form centered and to support the fresh concrete. The first section of the form was placed around the pile and hung from the structure above. It was then filled with concrete and lowered a sufficient distance to permit of setting another section of the form. This operation was repeated, the concrete always being deposited in the dry above the water level, until the protection had penetrated the bottom the required distance. The jackets were 20 in. in diameter and no reinforcement was used but the steel forms were not removed.

Several structures in which the piles were protected by this method were constructed in San Francisco Bay in 1908 and 1913. Nearly 2,000 were used in piers and wharves of the Standard Oil Co. and of these only a few have been replaced. However, more than 1,100 of these jackets were used over copper sheathed piles which required additional protection after only 3 to 4 years service. On the other hand, out of 300 installed for the Harbor Commission approximately 80 per cent have been removed.

One of the greatest difficulties in this type of construction apparently was that the jackets did not penetrate the bottom a sufficient distance, the result being that the piles were exposed by subsequent dredging or scour. Also, due to the absence of reinforcement, there was a tendency for the concrete to crack and spall due to impact after the weakening of the steel forms by corrosion. The experience of the Standard Oil Co., however, furnishes convincing evidence that long service can be expected from this type of pile jacket where the work is properly done.

Sectional wooden forms have also been used the only difference being in the details of the forms and that they were removed after the concrete had set. This permitted of an inspection by a diver and the repairing of defects as the work progressed. In 1921 more than 2,000 piles were jacketed by this process in this vicinity. While no conclusions can be drawn from such a short service record the process may be considered a success in this particular instance, as it permitted a very busy grain wharf to be kept in service with practically no interruption to business during the progress of the work.

Precast Jackets—Precast concrete jackets for wooden piling are of two general types, one in which the jackets are constructed and after curing are set in place over previously driven piles and the other in which reinforcing steel is secured to the surface of the pile and over this is applied the concrete or mortar covering, the pile with its jacket being driven as a unit. In order to simplify this discussion the former will be referred to merely as precast jackets and the latter as gunite coated piles, the covering being usually applied by means of a cement gun.

Gunite Coated Piles: This type of pile protection has been in use since 1912 when a number of gunite coated piles were driven in a marine railway in San Francisco Bay. In 1922 a pier was constructed for the Port of Tacoma, 1450 gunite coated piles being used in the wharf under the transit shed. In the latter work the protection was made from $1\frac{1}{2}$ to 2 in. in thickness and it was reinforced with 2 in. square mesh fabric made of No. 12 wire. The fabric was furred out $\frac{3}{4}$ in. from the piles and was securely fastened in position. At the bottom of the gunite coating a tapered chamfer 2 in. deep was cut in the pile so that a ridge would not be formed in the protection. The piles were set in a vertical position while the gunite was being applied and after curing for twenty days they were jetted into position, only the weight of the hammer being used to assist the jet. The service record of gunite coated piles is not complete but so far as can be learned they have given satisfaction.

Precast Jackets: Concrete jackets of this type have been constructed in a variety of sections, usually circular on the inside and square, octagonal, or circular on the outside. Sectional jackets have been designed with special details for connecting the sections as they were lowered into position. Full length, single jackets have been used, however, in most of the work which has been done by this method. The minimum thickness of shell was usually made from 2½ to 3 in., the inside diameter being sufficient to permit of introducing a pipe between the jacket and the pile for the purpose of pumping out and grouting the annular space. The jackets were driven into the bottom a sufficient distance to insure complete protection to the piles and reinforced concrete or concrete encased steel deck beams were usually used.

Precast jackets of this type were first used on the San Francisco waterfront in 1908. Between that time and 1911 approximately 300 were used in the construction of bulkhead wharves and in 1911 a pier was constructed in which 1,130 jacketed piles were used. Aside from some small cracks over the longitudinal reinforcing bars above the water line no defects have developed in these jackets.

Comparative Advantages—In weighing the merits of different types of construction, durability and cost are the prime factors. And in considering durability, the most convincing evidence is that of service records. Based on such records as are available we may conclude:

When properly designed and constructed, reinforced-concrete jackets constitute a satisfactory and dependable protection for wooden piling in waters infested by marine borers. Such jackets should always penetrate the bottom a sufficient distance to insure that the piles will not be exposed by subsequent dredging or scour. The concrete should be reinforced by the use of steel bars or wire fabric.

Cast-in-place jackets when used in water more than a few feet in depth are difficult to construct. If wooden forms are used the percentage of failure is apt to be high. The use of steel forms left in position will materially increase the average length of service of jackets of this type.

Gunite coated piles have given satisfactory service for more than 12 years with no serious deterioration.

Precast reinforced-concrete jackets have been in use for at least 18 years without a recorded failure. They have been used successfully in water up to 42 feet in depth.

New Pacific Coast Work—The results thus far obtained from the use of full length, precast reinforced-concrete pile jackets have been so satisfactory that they are being used in Pier 50 which is now under construction by the Board of State Harbor Commissioners in San Francisco. They are also being used by the Alaska Packer Association in the Encinal Terminals wharves in Alameda and by the Harbor Commission of San Diego in the construction of a pier and a bulkhead wall for tideland reclamation.

Pier 50, the inner unit of which is now under construction, has a width of 386 ft. and when completed it will have a length of 1,450 ft. At present it is being built 600 ft. long. There are two flush tracks on each side and three depressed tracks and a driveway down the center. The sections under the outside tracks, having a width of 30 ft. on each side, are of creosoted pile and timber construction. The remainder of the structure is of reinforced concrete on jacketed piles. The conditions are ideal for this type of construction as the bottom is of such a nature that piles from 70 to 90 ft. in length are required while the jackets are only from 26 to 41 ft. in length.

In previous work by this method the wooden piles were driven tip down as is the usual custom. In Pier 50, however, they are being driven butt down. This gives increased bearing value and permits of using jackets 14 and 16 in. in inside diameter instead of 18 to 20 in. as would be necessary if they were to be placed over the butts of large piles. It also facilitates the introduction of pipes for pumping and grouting. The jackets are circular on the inside and octagonal on the outside, the corners being chamfered on a 4-in. bevel. Two sizes of jackets were used depending on the length, the minimum outside dimensions being 20 and 22 in. and the minimum thickness of shell 3 in. The reinforcement consists of 8 ½-in. square deformed bars spirally wrapped with No. 6 wire on 4 in. pitch. The longitudinal bars protrude 2 ft. for bonding into the deck.

The concrete consists of one part of cement to 4½ parts of graded aggregate. It is mixed fairly dry and is thoroughly tamped and spaded after being deposited in the forms. The jackets are kept covered with wet burlap for two weeks and are not handled for 30 days after being cast. As they are set in position over the piles, the mud is forced out by means of a gasket made of old rubber hose, after which they are sealed by grouting under water. When this grout has set the space between the jacket and pile is pumped out and filled with concrete. The deck is of reinforced-concrete construction.

The wharves at the Encinal Terminals are being constructed along one side of a dredged slip about 1,500 ft. in length. Except for modifications in design on account of different local conditions the construction is similar to that at Pier 50. Municipal Pier No. 2 at San Diego is 1,000 ft. in length and 500 ft. in width and consists of a suction dredge fill with reinforced-concrete wharves over the slopes at the sides and outer end. Concreted jacketed wooden piles were used in the two inner rows and reinforced-concrete piles in the remainder of the work.

The fact that the jackets are capable of adjustment as to position over the piles was taken advantage of in the bulkhead walls which were built in conjunction with the piers and wharves referred to and also in the wall which is now under construction in San Diego. In this wall which is 3,000 ft. in length, the jackets are square on outside except for small chamfers on the corners. The piles are driven on 10 ft. centers and as the jackets are set they are turned so that the faces make an angle of 45 deg. with the axis of the wall and so that they are vertical. Precast reinforced-concrete slabs are used to close the intervening spaces and each jacketed pile is anchored into the fill on the inshore side by means of a reinforced-concrete tie and a timber anchor. This is typical of the work at the Encinal Terminals except that brace piles were used instead of inshore ties. In Municipal Pier No. 2 at San Diego the jackets were set square with the axis of the wall and the slabs rest against the flat face. The same detail is being used in Pier 50 in San Francisco.

Comparative Costs—Based on the contract price for Pier 50 the following unit costs of precast jacketed piles are presented:

Cost of 20-inch jacket per lin.ft.	$1.95
Cost of concrete fill per lin.ft.	.26
Total	2.21
Cost of 22-inch jacket per lin.ft.	$2.17
Cost of concrete fill per lin.ft.	.37
Total	2.54
Cost of pile per lin-ft.	$.307
Driving pile and setting jacket—each	13.70
Cost of 85 ft. wooden pile with 20 in. jacket 30 ft. in length. Pile 85 ft. @ $0.307	$25.09
Jacket 30 ft. @ 2.21	66.30
Drive and set pile and jacket	13.70
	$106.09
Cost per lin.ft. in place	$1.25

It will be clear from the descriptions given above that the precast concrete jackets as at present used are in effect reinforced-concrete piles with wooden cores. As the relative lengths of the jacket and pile approach each other due to bottom conditions a point is reached at which it is more economical to omit the wooden core and use a solid concrete pile. This was done at the outer end of Pier 50 and in the outer rows in Pier No. 2 at San Diego. The adaptability to varying conditions, the rigidity and durability of the resulting structures and the relative economy are the principal characteristics of this type of construction.

Trunk Line Highway Costs in Connecticut

The report of the state highway department of Connecticut for the fiscal year ending June 30, 1925, giving gross expenditure for the year as $10,801,697, includes as expenditure for trunk line roads $8,785,180 for repairs and reconstruction work and $308,887 for new construction. Elimination of dangerous trunk line conditions, especially at Hamden and Newington, and grade crossing elimination at Saybrook were included.

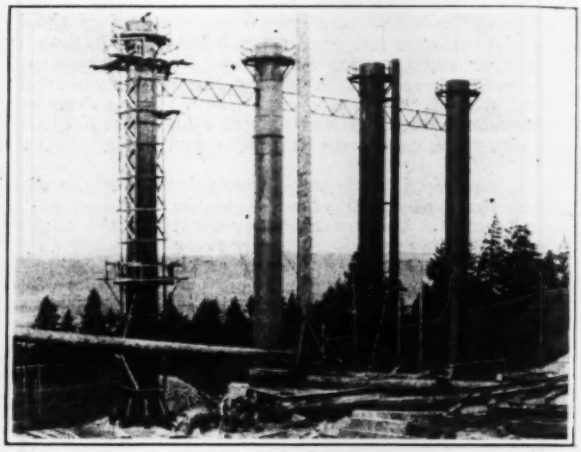
Unusual Penstock Arrangement at White River Plant

Economical Scheme for Supplying New Unit From Two Existing Pipe Lines Involves "Fish-Mouth" Connections

IN ADDING a fourth unit to the White River hydro-electric plant on the system of the Puget Sound Power & Light Co. near Seattle, Wash., a plan was worked out whereby the penstock supplying the new unit would not require separate headworks but at its upper end would tap into two of the existing penstock lines. This was possible because the two penstocks tapped had a capacity in excess of the demand upon them and could each contribute part of their flow to the new penstock line without affecting the efficiency of the machines they served.

The plan followed, as shown in the accompanying illustrations, was to divide the new penstock at its upper end into two branches (*A* and *B*) and to lead these into penstocks 1 and 2, respectively, by means of "fish-mouth" or oval connections. After riveting the connections in place, and before cutting the openings in lines 1 and 2, each joint was stiffened and weighted down by pouring a 90-cu.yd. reinforced-concrete anchor pier around it. When the enveloping concrete anchor had set, the plate steel between the main penstocks and the branches just connected was cut out and the new lines put in service.

It was, of course, necessary to keep the plant in operation as much as possible while this work was going on and work was therefore so arranged that one of the units could be cut out during the early hours of the morning, and the work was laid out so that a portion



FIGS. 1 AND 2—CONNECTING NEW PENSTOCK TO EXISTING PIPE LINES, AND NEW SURGE PIPE IN PLACE
In Fig. 1, *A* and *B* are the branches of the new penstock 4. Formwork at left ready for concrete anchorage around joint. Reinforcing steel and formwork being placed in right foreground. Numerals 1, 2, 3 and 4 indicate standpipes on the four penstock lines. *E* is exciter penstock standpipe.

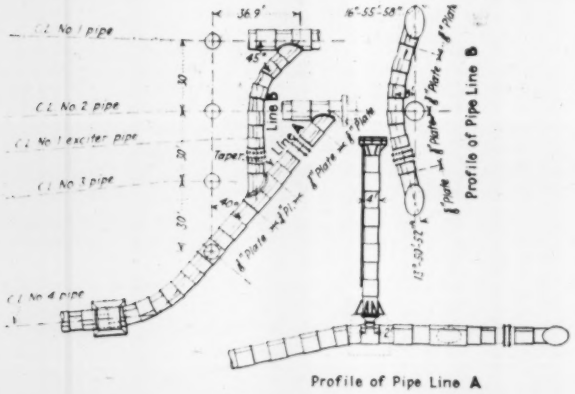


FIG. 3—PLAN AND PROFILE OF CONNECTIONS AT UPPER END OF PENSTOCK

could be done each night without taking the unit out of service during the day time. Butterfly valves were installed in each of the two branches controlling the water supply.

The new unit served by penstock 4, which was put in service early in 1925, is a single, horizontal runner, double discharge Francis type turbine, with a capacity rating of 23,000 hp.

Steelwork for this job was supplied by the Willamette Steel Pipe Co. W. D. Shannon was construction engineer for the Puget Sound Power & Light Co., which is a subsidiary of Stone & Webster, Inc.

Transportation Survey for Prospective Yale Courses

Under the auspices of the Strathcona Fund at Yale University, a survey is at present being conducted to determine what program of graduate studies in transportation at Yale is best adapted to the needs of the country and to the personnel and facilities at the University's command. It is being conducted under the general direction of the committees of the Yale faculty consisting of Winthrop M. Daniels, professor of transportation; Charles J. Tilden, professor of engineering mechanics, and Samuel W. Dudley, professor of mechanical engineering. Victor Topping, a Canadian engineer who has specialized in the transportation field, is conducting the basic work for the survey. Opinions of practical transportation men are being sought as to the subject of instruction in any branch of this field, what the major transportation problems are, and how they are being handled by various bodies.

Continuous CO Recorder in the Liberty Tunnels

Special Instrument Devised for Supervision of Ventilation in Long Tunnel From Fan House on Surface—Draws Continuous Diagram and Gives Alarm When CO Percentage Becomes Excessive

By A. C. Fieldner, Superintendent and Supervising Chemist; S. H. Katz, Associate Physical Chemist, and E. G. Meiter, Assistant Physical Chemist
All of Pittsburgh Experiment Station of the U. S. Bureau of Mines

CARBON monoxide production by automobiles in the Liberty Tunnels, Pittsburgh, has been discussed in two previous papers (*Engineering News-Record*, Aug. 21, 1924, p. 290, and Dec. 25, p. 1022, "Natural Ventilation in the Liberty Tunnels," and "Carbon Monoxide Under Traffic in the Liberty Tunnels," by Fieldner, Yant and Satler). Operation of the ventilating machinery started Aug. 1, 1924, and has continued daily as needed ever since. Its operation is supervised and controlled by aid of an automatic carbon-monoxide recorder, described in the present article. The recorder, Fig. 1, was developed at the Pittsburgh Experiment Station of the Bureau of Mines, and was installed by arrangement with A. D. Neeld, consulting engineer for the tunnel to the county commissioners.

The ventilating machinery is situated in the fan house above the tunnels, and consists of eight motor-driven fans. (The system was described in *Engineering News-Record*, May 7, 1925, p. 764, in "Exhaust-and-Supply Ventilation of a Long Street Tunnel.") Four of the fans exhaust air through upcast shafts from the entrance half of each of the two tunnels, this air entering at the respective portals and traveling longitudinally to the shafts. The other four fans blow fresh air through downcast shafts into the other half of the tunnels, the air being injected longitudinally through nozzles in the side walls and leaving the tunnels at their respective exit portals.

Permissible CO Concentration—Four parts of CO in 10,000 parts of air was determined as the maximum concentration to which a person may be continuously exposed for one hour without noticeable effect; or, if the concentration is increased from zero uniformly for one hour, the maximum tolerable concentration is six parts per 10,000, averaging three parts for the hour (Henderson, Haggard, Teague, Prince and Wunderlich, "Physiological Effects of Automobile Exhaust Gas and Standards of Ventilation for Brief Exposures," *Jour. Ind. Hyg.*, August, 1921, p. 72 and p 137). The condition of gradually increasing carbon monoxide prevails at the Liberty Tunnels through each half of the tunnel length.

The adequacy of the ventilation of the tunnels when in use can be determined either by a staff of chemists analyzing samples of the tunnel atmosphere, as was done in the case of the analyses reported in the previous papers of this series, or by automatic apparatus to analyze and record continuously the concentrations of carbon monoxide. Recording apparatus was deemed preferable because of the rapidity and continuity of records as well as lower maintenance expense. However, as heretofore no automatic apparatus had been made capable of recording continuously the very low percentage of CO, development of a suitable CO recorder was undertaken by the Bureau of Mines.

The principle employed in the successful instrument is measurement by means of thermocouples of the increased temperatures of the gases when the CO and oxygen react chemically in presence of a catalyst, the thermo-electric effects being recorded by means of a recording potentiometer. After extended experimentation and development a recorder was produced which is not appreciably affected by the presence of other gases, and which is capable of indicating and recording the highly diluted CO. Concentrations are expressed on the records in parts by volume of CO per 10,000 parts of air-gas mixtures, and the recorder is sensitive to 1 or 2 parts per million. Trial operations in the laboratory over a period of six months, analyzing air containing exhaust gas from a gasoline engine, proved it to be reliable.

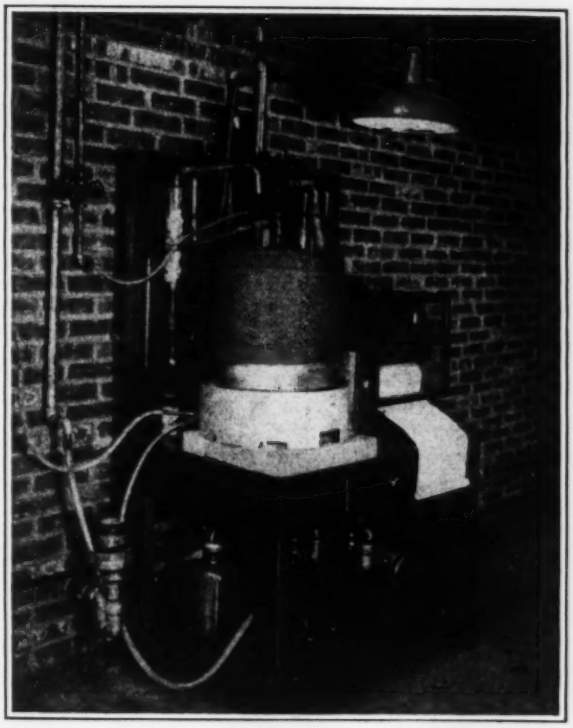


FIG. 1—LIBERTY TUNNEL CO RECORDER

Description of Recorder—The recorder, Fig. 1, is shown by diagram of essential parts in Fig. 3. The instrument is equipped with a bell to warn attendants in the fan house should the CO at any time exceed 4 parts in 10,000, through fire, accident or excessive traffic in the tunnel. The bell-ringing system can be made to operate a relay switch to increase ventilation automatically by supplying increased power to the fan motors, but this has not yet been done. Further, the recorder can effect considerable saving in power at the fan house if the chart is read regularly and the volume of air is

reduced when the CO is low. At this writing, June 1, 1925, the CO recorder has operated continuously and satisfactorily for ten months.

One of the authors (S. H. Katz) has applied for a patent on the processes and apparatus described.

A Typical Record—The record for Wednesday, Oct. 1, 1924, is presented as typical in Fig. 2. The sample for the recorder was drawn continuously from the housing of the exhaust fan on the north half of the west tunnel, which conducts the traffic southward, outbound from Pittsburgh. The fans are operated from about 7 a.m. until nearly midnight. As long as the fans operate the gas sample taken by the recorder is truly representative of the tunnel condition. From midnight through the early morning hours, the tunnels have natural ventilation. During these hours ventilation may be caused by the wind, by differences in barometric pressure, or by the traffic in the tunnel. On the other hand, mass movements of air may cease entirely on quiet nights, at intervals when there is no traffic. At times of natural ventilation, movement of air in the ventilating shafts, in the air passageways in the fan house above the tunnels, and in the stack vents, may be either upward, downward, or altogether stopped.

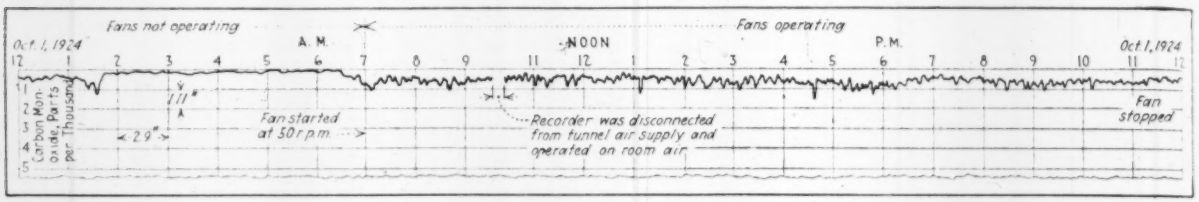


FIG. 2—TYPICAL CO RECORD (NORTH HALF OF SOUTH BOUND TUNNEL, WEDNESDAY, OCT. 1, 1924)

Fig. 2 shows a peak at 1:35 a.m. of about 1.3 parts of CO per 10,000. This is probably due to warm exhaust gas rising in the ventilating shaft, and so tending to accumulate some CO in the fan-house airways above. Mass movements of air through the fan house must have ceased. Hence this peak probably does not represent conditions in the tunnel at the time, although it indicates the true concentration of CO in the fan enclosure at the point from which the recorder draws its air sample. After this peak the CO dropped rather abruptly and continued at about 0.1 to 0.3 part per 10,000 until 6:30 a.m. This probably represents actual conditions in the tunnel with a natural ventilating current carrying tunnel air upward through the fan house to the discharge stacks; however, no observations on the ventilation were made then to ascertain this.

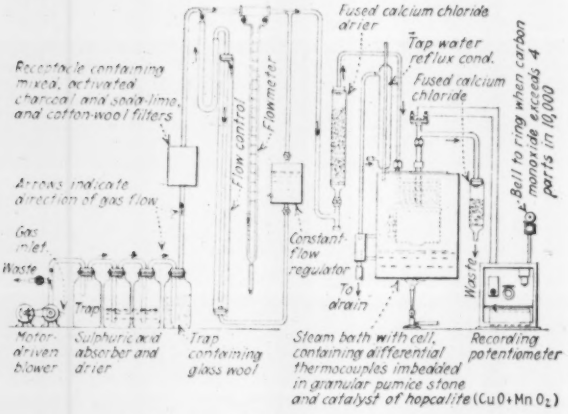

Fused calcium chloride drier
Tap water reflux cond.
Fused calcium chloride
Receptacle containing mixed, activated charcoal and soda-lime, and cotton-wool filters
Flow control
Flowmeter
Bell to ring when carbon monoxide exceeds 4 parts in 10,000
Arrows indicate direction of gas flow
Gas inlet
Waste
Trap
Constant-flow regulator
To drain
Waste
Motor-driven blower
Sulphuric acid absorber and drier
Trap containing glass wool
Steam bath with cell, containing differential thermocouples imbedded in granular pumice stone and catalyst of hopcalite (CuO+MnO2)
Recording potentiometer

FIG. 3—DIAGRAM OF ESSENTIAL PARTS, LIBERTY TUNNEL CO RECORDER

About 6:30 a.m. there was a sharp increase in the CO. The fans were started at 50 r.p.m. about 7 o'clock, and apparently drew out some accumulated CO because the concentration rose to about 1.1 parts per 10,000 and then decreased. At 9:40 the recorder was stopped to clean, oil and ink the mechanism and add about 3 lb. of fresh sulphuric acid; the attention of a man for 10 to 30 minutes is needed daily for these duties. During most of the day the concentration ranged around 0.5 and occasionally rose to about 1.0 part per 10,000.

Between 4:30 and 6:30 p.m. the traffic peak occurs in this (outbound) tunnel. The recorder shows a maximum for the day about 1.6 parts per 10,000, and between 5 and 6 p.m. the CO ranged around 1.0 part per 10,000. Thereafter the concentration was mostly below 1.0 part, ending with 0.4 part per 10,000 at midnight.

Value of Continuous CO Determination—The installation of the apparatus for continuous and automatic determination of carbon monoxide has enabled the officials in charge of the tunnels to adjust the speed of the ventilating fans at all times to that actually required to dilute the motor exhaust gases to the required safe figure. If heavy traffic suddenly jams in the tunnel and increases the CO concentration to above 4 parts per 10,000, a warning gong automatically signals the attendant to increase the fan speed. This incident has taken place once in the Liberty tunnels. The increased fan speed following the signal immediately reduced the carbon monoxide concentration to less than 4 parts in 10,000. Usually the records show less than 1 part CO in 10,000 parts air.

One recorder can be combined with 4, 6, 8 or more indicating thermocouples, so that a single record sheet will show the analysis of the air from various sections of the tunnel. There should be analyses made continuously of each section of the tunnel that is independently ventilated.

Complete records of the carbon monoxide content of the tunnel atmosphere are almost indispensable to public health. Without such records, moreover, the operating officials may often be placed in embarrassing positions by persons claiming to have suffered injury to their health due to inadequate ventilation.

Full description and details of the apparatus will appear shortly in U. S. Bureau of Mines technical paper 355 entitled "A Monoxide Recorder and Alarm," by S. H. Katz, D. A. Reynolds, and J. J. Bloomfield.

Tar Sands Being Tried on Roads

Thirteen carloads of tar sands from Waterways, in northern Alberta, have been shipped to Eastern Canada this summer for the purpose of experimental road building at various points in the eastern provinces.

Engineering in the Small City

A series of notes from the field on the Problems and Practices of the Municipal Engineer in the Cities Below 100,000

The Editor Visits the City Engineer

Snapshots of Our Representative Small Cities

Middletown, Ohio

"OL' SWIMMIN' HOLE" MIDDLETOWN, OHIO

CITY IN BUTLER COUNTY, OHIO, on Miami River, 34 miles north of Cincinnati. Large manufacturer of steel products, steel sheets, paper, tobacco, bicycles, paper boxes and bags. Settled as early as 1794. Adopted commission form of government in 1913. Pop. (est. 1924) 30,000.

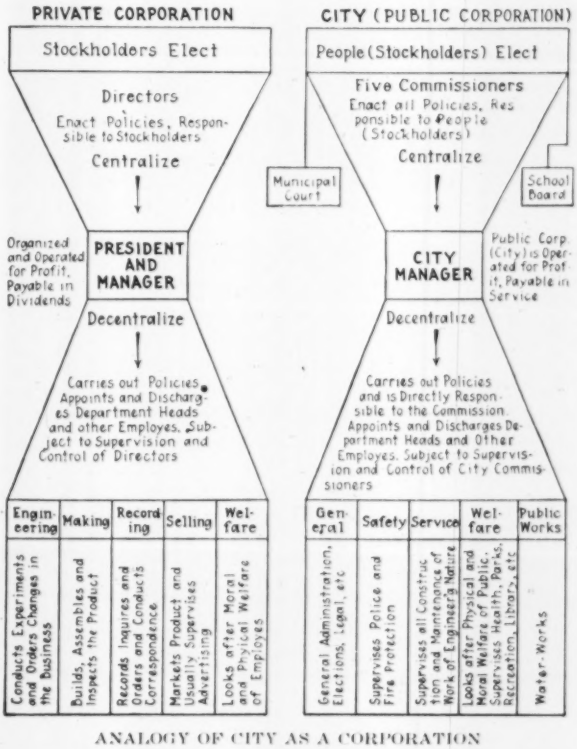
TRAVELING in late April from Cincinnati northward to the flat valley of the once treacherous Miami River, the railroad passenger looks from the car window first on a right-of-way carpeted with violets and lined with the flaming Judas tree. Beyond, well-dressed farmhouses stand guard over endless acres of sprouting grain. If he is thinking about the first express stop and knows nothing of its business history, the traveler visualizes the city, Middletown, as the busy trading center of an extensive agricultural community. However, Middletown is a steel town and the story of its development is inseparable from the development of the American Rolling Mill Co.

The commission form of government became operative in Middletown in 1913. In 1920, disregarding an overwhelming majority against employing a city manager the city commission enacted an ordinance giving the city such an officer. The present incumbent is L. A. Waldner, who first appeared in Middletown as superintendent of construction for Westinghouse Church Kerr Co. He is a young man combining both administrative and technical abilities and it has been his difficult task to try to override a tremendous unpopularity with which the office he holds once was viewed. Mr. Waldner considers the city a public corporation, the people being the stockholders, who elect the five commissioners, representing directors. He represents the president and manager of this large public enterprise, which is being operated for profit, the profits being paid in municipal services. This analogy between the organization and operation of a city under a manager and a private corporation is explained graphically on a table in Mr. Waldner's office, as given here.

The city commission divides its work into general, safety, service, welfare, and public works. The waterworks is a bureau within the Department of Public Works, other engineering services being included in the Department of Public Service. The latter department supervises all construction and maintenance of work of an engineering nature. Though the city manager has control over all five of these departments and is particularly interested in the Departments of Public Service and of Public Works, to a city engineer (W. C. Morrison) in the former bureau and to a superintendent of water-works (Earl Gebhart) in the latter are delegated direct responsibilities.

Middletown appears to have an extraordinary pride in its public appearance. It is a very well dressed town. Its clean, wide, paved streets are the joint pride and satisfaction of its citizens and the municipal engineering staff.

There are 64 miles of city streets and of this amount 18 miles are sheet asphalt, 5 miles brick and 4½ miles reinforced concrete. Altogether, practically half of the city's street mileage is paved. The city has done some experimenting with bituminous macadam on crushed stone base, bituminous macadam on concrete base, bituminous macadam on old brick, waterbound macadam covered with Tarvia and waterbound macadam covered with Kentucky rock asphalt. The last-named type has given extraordinary results, but the city commission


PRIVATE CORPORATION
Stockholders Elect
Directors
Enact Policies, Responsible to Stockholders
Centralize
Organized and Operated for Profit. Payable in Dividends
PRESIDENT AND MANAGER
Decentralize
Carries out Policies. Appoints and Discharges Department Heads and other Employes. Subject to Supervision and Control of Directors
Engineering
Conducts Experiments and Orders Changes in the Business
Making
Builds, Assembles and Inspects the Product
Recording
Records Inquires and Orders and Conducts Correspondence
Selling
Markets Product and Usually Supervises Advertising
Welfare
Looks after Moral and Physical Welfare of Employes
CITY (PUBLIC CORPORATION)
People (Stockholders) Elect
Five Commissioners
Enact all Policies, Responsible to People (Stockholders)
Centralize
Municipal Court
School Board
CITY MANAGER
Public Corp. (City) is Operated for Profit, Payable in Service
Decentralize
Carries out Policies and is Directly Responsible to the Commission. Appoints and Discharges Department Heads and Other Employes. Subject to Supervision and Control of City Commissioners
General
General Administration, Elections, Legal, etc
Safety
Supervises Police and Fire Protection
Service
Supervises all Construction and Maintenance of Work of Engineering Nature
Welfare
Looks after Physical and Moral Welfare of Public. Supervises Health, Parks, Recreation, Library, etc
Public Works
Water-Works

ANALOGY OF CITY AS A CORPORATION

seems to prefer sheet asphalt, so that type has prevailed and will continue to do so. Only about 8,000 sq.yd. of paving will be laid during the present construction season, though at the fall election, a paving program proposing the expenditure of $1,000,000 will be voted upon. In accordance with the Ohio state law, this bond issue would have to be liquidated inside the 9-year constitutional limit.

The greatest public question which the city of Middletown has to face is the adequate supply of water. The original well sunk more than 40 years ago was a brick structure about 25 ft. in diameter and about 50 ft. deep. This single well discharging directly into pits for pumping into service mains has long ago ceased to

collect water. Though that well at one time was always from one-half to two-thirds full, despite the demands made upon it, the city found it necessary to sink other wells, which in their turn have become exhausted. The present supply comes from a nest of eleven 6-in. wells, set about 1,000 ft. from the pumping station. These wells are connected to a 30-in. suction line led into the pump house. The pump house has one 1.5-m.g.d. and one 3-m.g.d. steam pump operating, which give the service main 60- to 80-lb. pressure. In the pump house also there is a waterwheel with a capacity of 1.25 m.g.d. Only a small percentage of this is used at the present time, though a survey is being made at the intake on the power canal, the idea being that a larger turbine may be installed and greater use be made of the power water for which the city pays rather high charges.

The use of industrial water and the consequent sinking of so many artesian wells makes the problem of water supply an important one, though one for which immediate studies are not considered necessary. Though the city mains pass about 5 m.g.d., it is estimated that at least 10 m.g.d. is used by the various industries—steel, paper and tobacco—from private wells.

While it might be expected that the city of Middletown would have a water softening plant, the superintendent of water-works explained that inasmuch as a large percentage of the city's supply goes toward industrial uses, it is considered an unwarranted expense. It is estimated that 75 per cent of the total supply goes to industrial uses, which include fire hydrants, boiler feed water, sewage flush tanks, etc. The fact that the city does not soften its water has led to the installation by a large number of householders of individual softening plants. The city is 100 per cent metered. Upon completion of the metering a number of years ago, pumping to maintain an 80-lb. pressure fell 25 per cent.

The city has a gravity sewerage system and all sewage discharges into the Miami River.

Dr. Lummis, health officer for the city of Middletown, a number of years ago made a thorough investigation of incinerating plants before the city took up the matter of constructing a plant for garbage disposal. After visiting a number of cities, Dr. Lummis recommended a high temperature incinerator which was built in 1920 at a cost of $15,984. The incinerator consists of two units with a capacity of destroying 15 tons of garbage every 24 hr. in each unit. Operation of the plant including the cost of fuel and salaries for two men amounted to $4,303 in 1923 and $4,041 in 1924. Garbage collection in these two years has cost $3,661 and $4,695 respectively. Receipts from collections made by the city at 10c. per can (which city furnishes) amounted to $1,800 in 1924. This sum is considered lower than it should be, so different methods are being devised for collection of the money for 1925. The net operating expense for garbage collection was $8,736 during 1924.

A number of new residential districts have been opened in Middletown in the past few years. Notable among these is that which adjoins the hospital site upon which is being erected a $1,000,000 structure. Incidentally, and as an indication of the readiness of citizens to aid a worthy public enterprise, the construction of this hospital was made possible through public subscription, the $1,000,000 being raised within a few weeks. The hospital is on a hill, which fact necessitated the installation by the city of a small booster pump for water supply, though at present but a few residences in addition to the hospital are benefited.

Engineering Work

The city has made ample provision for municipal recreational facilities. In one of its parks is a very neat structure—a swimming pool which follows the contour of the base of the hill and is near the booster pumping station. The pool is a large concrete basin, which has no symmetry whatever. Within the enclosure, which keeps the pool reserved for more or less limited public use, are a number of bath houses built of slab wood. The whole setting is more or less rustic and over the entrance of the bath houses "The Ol' Swimmin' Hole" has been painted. The pool at one end spills into a shallower basin, which is used as a wading pool for small children. Limbs of a large chestnut tree overhang the deep end of the pool, providing natural springboards.

One of the outstanding features in the city-manager plan of government in Middletown is the centralization of buying power. Mr. Waldner purchases around an average of $75,000 worth of supplies each year, the largest items being for construction equipment. He is empowered to buy up to a maximum of $500. Beyond that competitive bids are required to be taken.

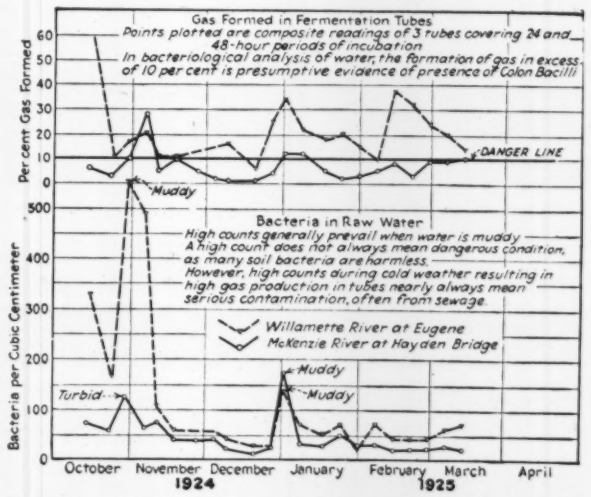
Publicizing Plans for Municipal Work

By S. Harold Evans
Portland, Oregon

PUBLICITY on proposed municipal improvements, to acquaint the voters with their need or advantages, is considered by many engineers as almost as important as are plans and estimates.

Stevens & Koon, consulting engineers of Portland, Oregon, have found, however, that the average layman is not much impressed by comparative figures, and that he needs a picture or a drawing—something that he can visualize and that is not too technical for him.

In the case of the $500,000 water supply project for the city of Eugene, Oregon, it was the series of illuminating graphs and charts prepared by Stevens & Koon on request of the city engineer of Eugene that allayed adverse criticism and won the project strong support. Eugene has a population of less than 20,000


Gas Formed in Fermentation Tubes
Points plotted are composite readings of 3 tubes covering 24 and 48-hour periods of incubation
In bacteriological analysis of water, the formation of gas in excess of 10 per cent is presumptive evidence of presence of Colon Bacilli
Per cent Gas Formed
DANGER LINE
Muddy
Bacteria in Raw Water
High counts generally prevail when water is muddy. A high count does not always mean dangerous condition, as many soil bacteria are harmless. However, high counts during cold weather resulting in high gas production in tubes nearly always mean serious contamination, often from sewage.
Willamette River at Eugene
McKenzie River at Hayden Bridge
Bacteria per Cubic Centimeter
Turbid
Muddy
Muddy
October
November
December
January
February
March
April
1924
1925

GRAPHS THAT AIDED IN SECURING WATER BOND VOTE AT EUGENE, OREGON

Of the Small City

people. The water board and many of the citizens realized that it was imperative that the city obtain a new source of water supply as soon as was possible. One of the newspapers, though, and many of the townspeople were strongly opposed to expending a half million dollars for water, contending that the water obtained from the proposed source was not enough better than that taken from the Willamette River to warrant the outlay. The proposed project called for piping water from seven miles up the McKenzie River.

The consulting engineers then prepared four charts. One showed that to place 10 m.g.d. in the city reservoirs by gravity delivery through pipes ranging in size from 24 to 30 in., as some of these opposing the project wanted to do, would necessitate going up the McKenzie River from 30 to 64 miles, depending on the size of pipe used. Another chart showed that raw water from the Willamette River, from which Eugene obtains its present water supply, is dangerously polluted, whereas the McKenzie River has raw water that is potable the year around. A third graph brought out the fact that because of the rapid growth of the city the capacity production of water was barely adequate for present needs. A fourth chart indicated the increase in electric power demand, and forecast the probable future demand for water and electric power.

These charts were reproduced in the local papers and explained before various civic bodies. The result was that the hostile newspaper completely reversed its stand, and in an editorial admitted that through not being acquainted with the facts of the situation it had been in the wrong. When the matter was placed before the voters the bond issue carried by a substantial majority.

Macadam Street Patrol Equipment

IN ROCKFORD, ILL., which has 78.5 miles of macadam paving out of a total of 122.3 miles of paved streets, two patrols handle the street patching and surface breaks caused by utility service installations. The patch is in effect asphaltic macadam and the equipment for placing it is as follows:

Two 2-ton trucks carry two 135-gal. tar kettles, mounted at the rear. Two-ply asbestos under a sheet of 16-gage steel protects the truck body. Removable side boards are placed between the cab and the kettles. In this space is a steel barrel for bituminous material which is applied cold on the top of patches to keep the top stone from being swept away by vehicles. The balance of the space is used for stone. Two-wheel trailers of the type used by the aviation branch of the army are used for different size stone. The front end of the trailer box was pointed to assist in making short turns. In it are kept tools. A cover was fitted over this end and a slot cut in the face which allows tool handles to stick out and still to be locked in.

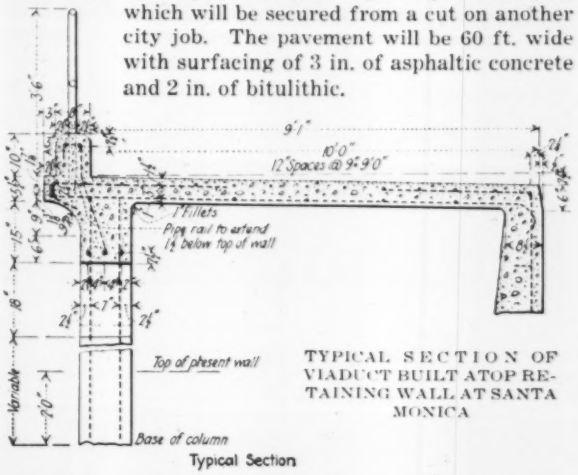
The cost for each outfit was $1,000 for the second-hand truck, $200 for the 135-gal. kettle; $91 for trailer; $40 for lumber and $44 for labor. The crew consists of a foreman, kettle tender, truck driver and a skilled laborer. A flat rate of 20c. per sq.ft. is charged the utilities, city sewer and water departments for patches.

All street repairs are handled by the city engineer, Bernhard C. Harvey.

Column and Beam Construction Will Save Santa Monica Expensive Wall Cost

A NOVEL form of column and beam construction has been evolved by City Engineer Howard B. Carter of Santa Monica, Calif., in certain street improvements which are now under way. On Colorado Ave., between Ocean Ave. and Fourth St., there existed a depression which was 12 ft. below grade at its deepest point. Two streets crossed this depression. It was decided to bring this depression up to grade, even though it necessitated burying a considerable stretch of good pavement beneath the fill. The improvement also includes an overhead crossing of concrete construction to eliminate a grade crossing with the Pacific Electric Ry. tracks. This bridge roadway will be 55 ft. wide, 30 ft. high at its highest point, and 150 ft. long. It crosses from Ocean Ave. at right angles to the other new construction. The distance from Ocean Ave. to Fourth St. is 1,600 ft. To conform to the new grade, ten houses along Colorado Ave. will have to be raised.

The fill will require about 50,000 cu.yd. of earth, which will be secured from a cut on another city job. The pavement will be 60 ft. wide with surfacing of 3 in. of asphaltic concrete and 2 in. of bitulithic.



TYPICAL SECTION OF VIADUCT BUILT ATOP RETAINING WALL AT SANTA MONICA

Northeastward from Ocean Ave. on Colorado Ave. for a distance of 320 ft. the street is retained by a reinforced-concrete cantilever retaining wall. It was found upon examination that this wall was not sufficiently strong to carry the additional load imposed by the new fill. The removal of the old wall and the construction of a new wall would entail a cost of approximately $50,000. The sidewalk space of 10 ft. runs the entire length of the wall, and under the new plans prepared by Mr. Carter this same width will be retained.

The method decided on by the city engineer's department was to extend the old wall up to the new grade with a reinforced column and beam construction. Columns will be tied together with a longitudinal reinforced-concrete beam at the top. The beam will carry an ornamental coping and a galvanized-iron pipe guard-rail. Portions of the old wall will be removed, to allow a thorough bond of the new columns to the old work.

On the street side of the 10-ft. sidewalk is a curb line. A reinforced cantilever retaining wall will be built to retain the new earth fill and will be tied to the column and beam construction with a reinforced-concrete slab. The slab will serve as a sidewalk.

The bid received on this new method was $8,000, so the property holders were saved by it the sum of $42,000.

Stevens Monument Dedicated by Historical Expedition

Historical Societies and Great Northern Railway Dedicate Monuments Marking Sites of Early Pioneer Interest

By Edward F. Flynn

Director of Public Relations, Northern Pacific Railway Co.

With the object of revivifying interest in the early history of the territory it traverses, and perpetuating accurate knowledge of historic landmarks, the Great Northern Ry. some time ago decided upon the erection of permanent monuments upon the historical spots of the old West and establishing the nomenclature of those days.

In pursuance of this policy the town of Falsen, in North Dakota, became Verendrye, in honor of the dauntless Pierre Gaultier de Varennes, Sieur de la Verendrye, the first white man to enter what is now North Dakota, in 1783, in his meandering quest for the Pacific Ocean. Likewise the town of Mondak in Montana, the name being an ingenious combination of Montana and Dakota, was changed to Fort Union.

Working in conjunction with the State Historical Societies of Minnesota, North and South Dakota, Montana and Missouri, under whose auspices it was carried out, the Great Northern Ry. recently conducted what was known as the Upper Missouri Historical Expedition, and on July 16 sent out a special train to commemorate the different historical events with appropriate ceremonies.

On July 17 a monument was dedicated at Verendrye to David Thompson who looped his travels here in 1797, sixty years after la Verendrye. From Verendrye the expedition moved to Fort Union, which has a history going back for a hundred years. In 1821 adventurous fur traders selected the confluence of the Missouri and Yellowstone Rivers as a point from which to control the trade of the West and Southwest. At that time travel was by river, and here came steamers from St. Louis to meet the Indian and the trapper canoes from the Rockies beyond Great Falls to the West and those that came from the basin drained by the Yellowstone southwest of Billings.

Fort Union, with the exception of Fort Garry, on the present site of Winnipeg, was the most imposing fur trading post in North America. It was palisaded with stone bastions 30 ft. high and protected with cannon. It was an imposing building, and in it life was lived with baronial dignity, tempered by the hazards of Indian warfare and ever impending danger.

The special train which had taken the party to the various points on the expedition arrived at Summit on the twenty-first of July at which time the John F. Stevens monument was unveiled and dedicated. This statute had been erected by the Great Northern Ry. at the point on the Continental Divide known as the Marias Pass, which was discovered in 1889 by John F. Stevens, engineer, who had for sometime been exploring for the purpose of finding a low altitude passageway over the Rocky Mountains, through which to build the railroad. His experiences are best conveyed by the distinguished speakers who addressed the notable gathering at Summit.

President Ridgway's Address—In his address Robert Ridgway, president of the American Society of Civil Engineers, said in part:

It is extremely gratifying to the board of direction and to the membership of our society as it is to engineers in general, to know that the Great Northern Ry. has recognized the debt it owes to its former chief engineer and is recording it in the form of an enduring and aesthetic monument placed at the strategic point of its long line, Marias Pass.

The erection of this commemorative monument is a particularly fitting and graceful act on the part of the railroad and its president, himself a member of our society, and it takes away from the force of the statement so often made that the achievements of the engineer are not recognized as they should be by the public they serve. I want to thank Mr. Budd for giving me the opportunity to be here and to add to those of others my words of appreciation of Mr. Stevens' services to his profession and to his country.

It is indeed fortunate that a figure like that of John F. Stevens appears amongst us from time to time to increase our faith in mankind and in the vitality of our American institutions. We may well take pride in the country that can produce such men. He is of the type of the pioneer New England stock whose sturdiness and stability of character, honesty of purpose and perseverance under discouragement have done so much to advance our nation to the proud position it occupies today. Faith in our country will be maintained as long as we can produce such men to take up the burden of service in so efficient and patriotic a way. In all probability he would have succeeded in any work he might have undertaken because the qualities he possesses make for success in almost every line of endeavor. But he was born to be an engineer and there is no doubt that his love for construction work and the desire to see the vision in his mind take the concrete form of the finished structure fitted him for greater success as an engineer than he would have attained in any other line of work. We of the American Society of Civil Engineers are very proud to claim him as an honorary member of our society.

This western section of our country was a great school for engineers during the period of 40 to 50 years ago. Only those who were sound physically, mentally and morally were graduated; the others gave up or fell by the wayside. The training developed self-reliance, resourcefulness, initiative and a good knowledge of men. There could be no leaning on others in an emergency. That would have meant failure. Each man stood on his own feet and faced the difficulties as they arose, taking each one as a matter of course and regarding the overcoming of obstacles as a part of the day's work. The men so trained were pioneers. They blazed the trail for others to follow because they had few precedents to guide them. Without men of this type our great western country would be decades behind in its development. No task was too great for them to undertake.

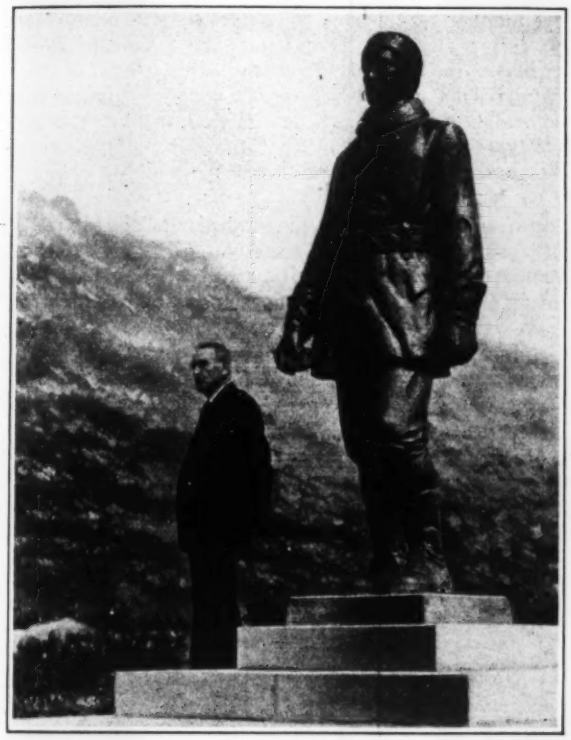
They possessed a large measure of common sense, which after all, constitutes at least 90 per cent of the equipment of the mind of a successful man. They advanced to success not because they were merely technicians but because the man was behind the engineer and as a reward for their accomplishments they were willing to let the work which they did speak for them. In such a school John F. Stevens was trained and how much he owes to this alma mater it would be hard to tell but I imagine he looks back with thankfulness to the years spent here and appreciates the value they were to him. Without the training of those years, I doubt if his later career would have been as brilliant as it has been. It prepared him for his great work at Panama and for those six trying years in Russia, Siberia and Manchuria where he added to his reputation as an engineer, a diplomat and a leader by his patriotic service rendered under most trying conditions.

To realize what a task was his from 1917 to 1923, read the admirable address of our former Ambassador to Japan, Roland Sletor Morris, which was delivered in New York at the ceremony at which the John Fritz Medal was presented to Mr. Stevens:

> The engineer's service to his fellow man is usually unobtrusive. Most of his best work is done in the quiet and is not known to the public. When some achievement excites the imagination of the latter, the engineer

is placed on the front page but he is conscious that the spectacular affair which is so advertised does not usually represent his best work. That to which he gives his best thought and energy frequently passes by unnoticed because it has no spectacular features about it. I do not believe that the good engineer does his work merely to invite public recognition. The consciousness of having done it well is a satisfaction in itself and it is always a privilege to be given the opportunity to serve. I frequently wonder what would happen to the engineer if his name was always on the front pages of our newspapers. I question if he would continue to be the man of the same efficient, constructive force that we like to think he is. Men like Stevens rise through transcendent ability and force of character, not through advertising.

The engineer is by nature and training, constructive, and he should take his place by the side of those other good citizens who by word and deed are helping in the fight to uphold the ideals and institutions of the



JOHN F. STEVENS STANDING ON MARIAS PASS BY HIS "BRONZE YOUNGER SELF"

country in which we have the privilege to live. With rare foresight and faith, our fathers reared our national structure on broad and deep foundations. It is our duty to maintain it and when on account of the development of the times it becomes advisable to add to or modify some of its details, let the work be done in a constructive and reverent way, taking care to preserve and not destroy the original design. All good men and women have poetry in their souls, but most of them lack adequate means of expressing it. Some are gifted with the ability to express it in works of verse or prose; some express it in music or in paintings and sculptures while a few, like the man we are honoring today, translate their thoughts into action and write their poems in the form of great engineering works which they leave behind to serve mankind. It is well for our country and for the world that such men live among us and are a part of us.

The Hon. Pierce Butler, Associate Justice of the United States Supreme Court, then spoke, saying in part:

It is appropriate that there should be at the summit of the Marias Pass over the Rocky Mountains a statue of John F. Stevens. He made the reconnaissance which disclosed and justified the use of this pass for the great purpose which it now serves. The Great Northern Railway Co., as a mark of its appreciation, has caused to be executed and placed here a permanent memorial of his achievement.

The reconnaissances made by Mr. Stevens before he reached this place are clearly and interestingly described in an address made by Ralph Budd, on the occasion of the presentation of the John Fritz Medal to Mr. Stevens March 23, 1925. "Mr. Stevens was alone, when, on Dec. 11, 1889, he reached this place. Because of the severity of the weather and what seemed to be insuperable difficulties, all the members of his party gave up before the summit was reached. A mixed blood was the last to accompany him, and he stopped about five miles away. Mr. Stevens went far enough to make certain that the summit had been reached. He spent the night walking about a fire he had kindled to keep from freezing to death; and after much exposure and hardship, returned to his base. His examination of the country had been so thorough that he was able to show that this was the lowest and best pass across the mountains. The actual location of the Great Northern through it at an altitude of 5,200 ft. on a one per cent grade westbound, and 1.8 per cent eastbound, and without a summit tunnel, fully confirmed his report. At one stroke the discovery of Marias Pass shortened the proposed line to the Coast by over one hundred miles, afforded far better alignment, much easier grades, and much less rise and fall.

The establishing of this pass was the beginning, not the end, of his inspiring career. In 1890 he became principal assistant engineer of the Great Northern; he thoroughly explored the country between Spokane and Puget Sound from Stampede Pass to the Canadian boundary. He found the best way through the Cascade Mountains, located the line and carried the work of construction to practical completion. That pass is called Stevens Pass. It is a fine example of his thoroughness, boldness and skill as a railroad engineer. Later he was made chief engineer of the system; and in all he served the company fourteen years. During that time its lines grew from three thousand to six thousand miles. He was recommended by Mr. Hill and appointed by William Howard Taft, then Secretary of War, as chief engineer of the Panama Canal, and chairman of the Isthmian Commission. He was influential in determining the type of the canal. He created an efficient organization to carry on the work. He planned and installed most of the plant required. Actual performance under his direction was more than sufficient to prove that the undertaking would be a success.

After his work on the Canal Zone, he became advisor to the government of Spain in respect to lines of railroad proposed to be built. Soon after the United States entered the Great War, the President sent him to Russia as chairman of a commission of railway experts. Later he was made president of the Inter-allied Technical Board to supervise the railroads in Siberia and Machuria in the territory occupied by the troops of the allies.

He has served splendidly in many parts of the world. He has been the recipient of many honors.

Mr. Stevens' Reply—After presentation to the assemblage of Gaetano Cecere, the sculptor who executed the monument of Mr. Stevens, the statue was unveiled by John Frank Stevens III, grandson of Mr. Stevens, and a response was made by Mr. Stevens, himself, who said in part:

The many years which I spent in the service of the Great Northern Ry., years which covered the best part of my active life, were by far, to me at least, the most satisfactory of my career. And I know that my association with, and the knowledge not only of railway affairs but knowledge of economics in general, which I gained from that master mind, James J. Hill, has been since I first met him the dominant influence in my working life, and to that influence and its teaching a great share of what small successes I have been permitted to achieve, is due. For clearness and tenacity of purpose, for vision and accuracy of judgment, he far surpassed any other man whom it has been my fortune to know during an active business life of more than fifty years, and I have come in contact with many whom the world calls great. This vast Northwest owes a debt to

Mr. Hill's memory, greater than to the memory of any other man who has passed across the stage of our country's history since we became a nation.

We have the best authority for the saying, "The old men shall see visions, and the young men shall dream dreams."

As one of the old men, I see visions, visions of a greater and more wonderful world than I have been privileged to behold, although my span of life has already covered the period of the greatest development, along all lines, which history records. And sometimes lately I have seen a vision that perhaps in the not distant future I may lie here at the feet of my bronze younger self, and listen to the sweet music of Mr. Budd's big engines talking to themselves as they pull up the long grades, over a route which I traveled thirty-six years ago, under much less comfortable conditions—these engines carrying the blessings of a much fuller civilization to millions yet unborn. Who can say?

It is a common truism that corporations have no souls. But I think that you will all agree with me that one corporation has a soul, and that it is wonderfully shown here today, and that besides soul, this one has lasting memory. I have neither the brain nor the tongue to give expression to the appreciation for what the Great Northern Railway has done for me. If I should attempt to do so, my feelings would drown my feeble words. I shall go down from this spot with a deeper appreciation of human brotherhood, and the feeling that a life of work and the knowledge that such work carries its own reward, and that I can count as not the least among my friends those whom it has been my lot to serve, in the years which are so rapidly receding.

Repairing a Failed Concrete Arch At Asheville

End Arch of Bridge of Six 75-Ft. Spans Sheared at Spring Line—Restored by Tangential Jacking After Blocking Up

By John B. Hutchings, Jr.
Chas. Waddell & Co., Engineers, Asheville, N. C.

In 1916 Asheville and its vicinity were visited by the worst flood in the history of western North Carolina. Nearly all bridges across the French Broad River were swept away and the emergency made it necessary to replace them immediately without much regard to design. Some of the structures were not designed properly and some have since failed. The failure of Smith's Bridge, crossing the French Broad River at Asheville, N. C., led to an unusual piece of repair work.

Before 1916 Smith Bridge, connecting the cotton-mill section at the foot of Spring St. with the west bank, was an ordinary steel highway structure of several spans. The flood washed it out, together with a large number of county steel highway bridges. Several local bridges of reinforced concrete withstood the flood successfully, and this fact no doubt influenced the county commissioners when they decided to rebuild Smith Bridge in concrete. The replacement was completed in 1917. The new bridge consists of one 43-ft. girder span and six 75-ft. barrel-arch spans. It carries an 18-ft. roadway and 4-ft. sidewalk on a deck 24 ft. 3 in wide.

In July, 1924, the bridge was reported as having failed. The local firm of Chas. E. Waddell & Co., consulting engineers, was retained as advisor to the County of Buncombe and was instructed to examine the bridge. Examination showed a pronounced sag in the west arch, and the west skewback sheared off on a horizontal plane, with a movement of 3 in. (Fig. 1). Several other spans showed a slight sag, but as the levels had not been referenced it was not known whether this could be ascribed to faulty formwork or was connected with the failure. The failure of the skewback was accompanied by considerable radial cracking in the under side of the arch barrel, which indicated that the arch ring was now acting partly as a beam.

A number of theories were advanced to account for the failure, among them being the vibration caused by blasts in the nearby quarry, the pounding from heavy trucks loaded with crushed rock, running over the bridge at speeds up to 18 to 20 mi. per hr., and poor quality of the concrete. On the latter point, however, the progress of our repair work showed the concrete to be dense and hard.

It appeared that either the west pier or the abutment, perhaps both, had moved slightly. Also, the skewback seemed not to have been properly cast, and horizontal shearing appeared to have developed along the line of cleavage formed by the end of one day's work and the beginning of the next.

The writer, for the above firm of engineers, suggested a method of repair, and the county officials agreed to furnish men and materials to carry it out.

About Aug. 1 a wing cofferdam was started at the bank some 100 ft. upstream from the west abutment. This was carried over to the first pier and pumped out, and an extensive cribbing of discarded oak crossties was erected under the west arch, as shown in Fig. 2. Upon the cribbing 24 and 30-in. steel I-beams

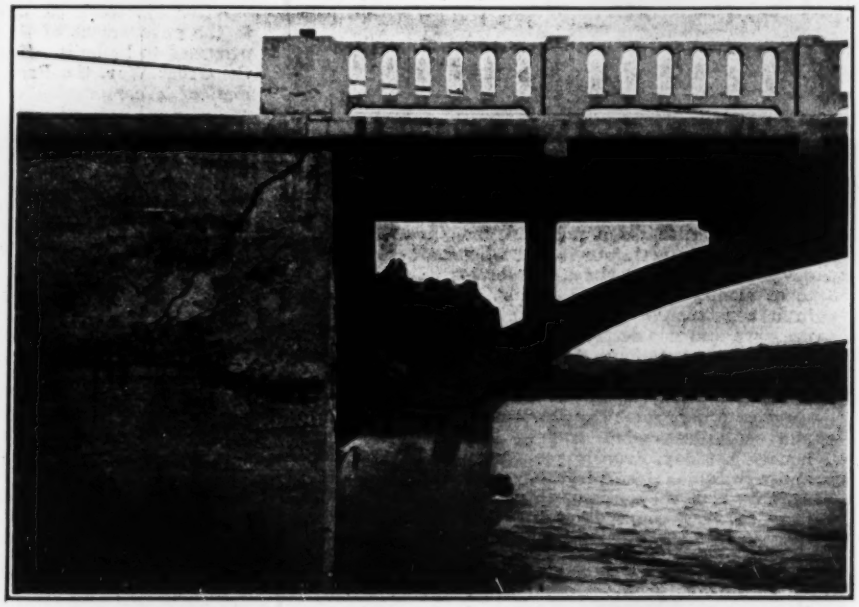
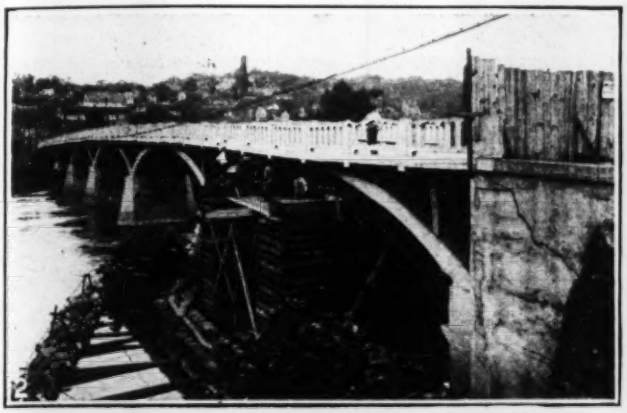
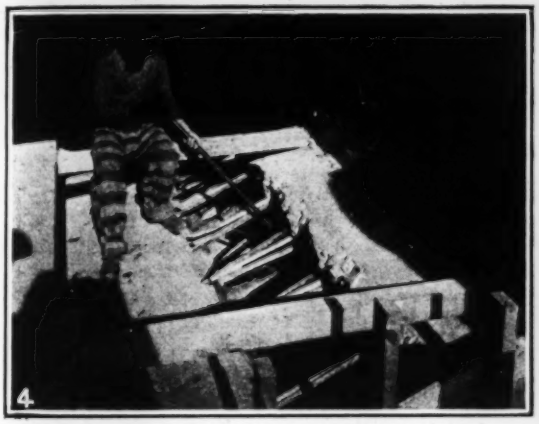


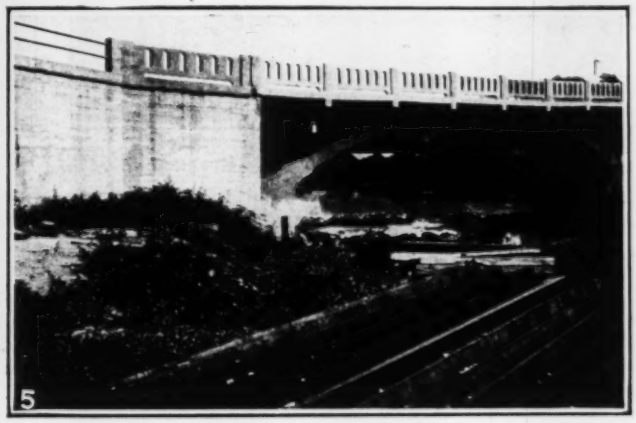
FIG. 1—WEST ABUTMENT END OF SMITH BRIDGE
Arch sheared off on horizontal construction joint.

were placed, and one-half the dead weight of the arch caught up on thirty large screw jacks. Care was taken to go around and raise each jack only a small amount each time, so that the process of lifting would not tend to produce any more stress and cracking of concrete. Diagonal struts of 12x12-in. yellow pine were put in place on the rock bottom and tightly wedged against the first pier about level with the spring line, to prevent any movement of this pier while repairs were in progress. The lifting jacks were nearer the west end, thus in Fig. 4, these jacks were placed parallel with the center line of the bridge, and tangent to the curve of the arch. They were set about 2 in. below the center of the arch ring depth, in an effort to cause the cracks on the lower face of the barrel to close.

The lifting jacks and the jacks in the arch ring were all tightened up together over a period of several days, so as to allow the stresses in the concrete and steel to readjust. In this way the entire arch ring (for this one span) was gradually returned almost to







FIGS. 2 TO 5—SUCCESSIVE STEPS IN REPAIR OF SHEARED ARCH AT ASHEVILLE

Fig. 2—Blocking up the arch.
Fig. 3—Cutting out broken concrete.
Fig. 4—Jacking the arch longitudinally.
Fig. 5—Jacks concreted in.

allowing the undamaged east end of this span to act as a hinge and carry part of the load.

As soon as the lifting jacks had taken all their load, excavation was commenced behind the west abutment, to prepare a more substantial abutment against arch thrust. This excavation was carried down 6 or 8 ft. below the original footing, in an effort to find sufficient foundation. Foundation at this point was partly large gravel, and partly the soft top of ledge rock. Some 70 to 80 cu.yd. of cyclopean concrete were placed.

As work was proceeding on this addition to the west abutment, a new skewback had been cut, and a 48-in. length of the arch ring taken out for the entire width of barrel. It was found here, as the reinforcing steel was uncovered, that many of the 1-in. bars were bent, broken, or sheared (Fig. 3). A thickness of 12 to 14-in. of rich concrete was now placed on the new skewback to form a base for eight 12 to 16-ton screw jacks, with bearing plates top and bottom. As shown its original location. All cracks in the under side of the arch barrel appeared closed, when examined with a small hand glass. Some movement at the expansion joint in the deck, over the center of the first pier, indicated that the pier or even the entire bridge may have been affected, first by the failure and later by stresses the jacks had produced. There was no way to check the exact condition of the pier, and as the apparent movement was only ½ in. it was thought safe to neglect it for the present.

After the lifting had been completed, all broken reinforcing bars were spliced, and other bars were run crossways in both directions around the eight jacks in the arch ring. Then on Jan. 6, 1925, rich concrete was filled into the gash across the barrel, embedding the tangential jacks. Dead-load was carried on the cribbing until Feb. 4, or four weeks, before the lifting jacks were removed and the bridge finally thrown open to traffic.

Repair of Concrete Road Blow-Ups in Delaware

Occurrence and Causes of Temperature Breaks—Types of Breaks and Repair Procedure —Cost and Equipment

QUICK and inexpensive methods of repairing blow-ups of concrete paved roads have been developed by the state highway maintenance forces of Delaware. These risings of the pavement, counting small and large, are quite common under certain conditions and their quick reduction is necessary both to prevent accidents to vehicles and because delay permits traffic to extend the shattering and increase the difficulties and cost of repairs. They are rather regarded, then, as emergency cases and special equipment is provided for quick attention and ordinary maintenance tasks are postponed if necessary until a blow-up is taken care of.

The causes of blow-ups are something of a speculation. There is expansion longitudinally of the paving slab. This causes it to hump up or arch at some weak point, generally a traverse joint. The rise is from a fraction of an inch to 18 in., and there is an amount of cracking and shattering depending upon the extent and character of the expansion movement and on other conditions, as slab strength. Blow-ups are most common on long flat tangents and on a sand subgrade. On clayey subgrade the greater bottom friction appears to hold the slab. Where there are frequent vertical or alignment curves, they appear, like bends in a steam pipe, to take up the expansion without disruptive movement. The most frequent occurrence of blow-ups is when a hot day is followed by a rainy night succeeded by another hot day, causing both temperature and moisture expansion.

The action of blow-ups varies. As stated the pavement may barely rise off the subgrade or it may hump up a foot or more. On high blow-ups the longitudinal shove of the slab has been traced 800 ft. back from the break. Two views of a high blow-up are shown by Figs. 1 and 2. Note the position on a long flat tangent, the shattering of the slab at the break, and the back breaks. Where the rise is little, there may be no visible break but only a slight hump disclosed most commonly by the hollow sound given by the slab as it is ridden over. With a somewhat greater rise the break spalls top or bottom but there are no visible back breaks such as are clearly shown in Figs. 1 and 2. The spalling or shattering varies. It may be on both sides of the break and rather uniform across the slab or it may be all on one side of the break and on one side of the slab as in Figs. 1 and 2. There may be corner cracks or lateral or diagonal shoving although these are uncommon occurrences. Sometimes instead of arching one slab rides up onto the other.

Types of blow-ups and methods of repair are indicated by the diagrams—not to scale—of Fig. 3. Generally the method of repair is to make a cut across the slab wide enough to embrace the shattered or spalled area. This cut is cleaned out, the slab drops into place and the gap is filled with Amiesite. The condition of a slight rise is shown at *A*. The spalled area is cut out. Generally the slab is under pressure, so the gap has to be cut carefully to avoid concentration of pressure which will cause a further corner break or an explosion upward. Sometimes these explosions have thrown chunks of the slab high in the air. The preferred method of making the cut is indicated at *C*. The cut is worked in from each side toward the middle leaving the projection or tongue to hold the shove. Then under the tongue a hole is dug in the subgrade large and deep enough to hold this projection when it is finally cracked off by further cutting. Without the hole the tongue would fall under the slab and block it up and have to be removed with difficulty. When the rise is higher as at *B*, so as to clear the subgrade and cause back cracks, the method of making the cut is the same, but first—and this is considered highly important—the shoulder is cut out along the slab edges as far back, as *a-b* and *c-d*, at least as the back breaks. Then any material that has crowded under the lifted slab is raked out.

The third type of break is shown by the diagrams *D*.

FIG. 1—BLOW-UPS OCCUR ON LONG FLAT TANGENTS

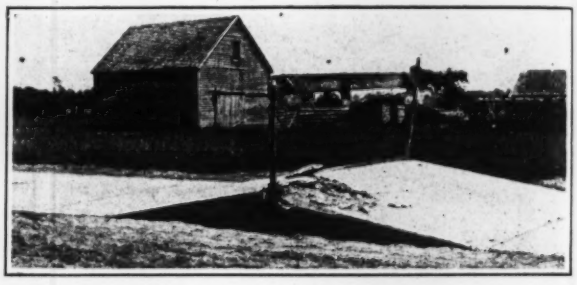


FIG. 2—RISING SLABS SHATTER AND BACK BREAK

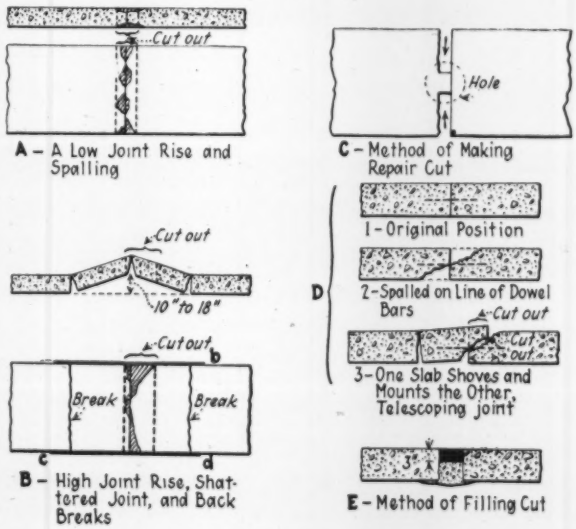


FIG. 3—TYPES OF BLOW-UPS AND REPAIR METHODS

Here the slab splits and spalls out on the horizontal plane of the dowel bars; one slab rides upon the other, and the mounting slab back cracks. In this case the repair cut is made as indicated by the third diagram *D* of Fig. 3, the dowel bars being disposed in any way that seem feasible, but they are generally cut off.

The cut is filled with tamped stone, generally the concrete broken up in making the cut, to within 3 in. of the surface of the slab. The subgrade under the cut is tamped hard and so is the stone fill. For the top 3 in. of fill commercial Amiesite top dressing is used. Generally Amiesite fill is used in cuts no wider than 18 in. If used in wider cuts it is not easy to keep level with the adjoining concrete slabs. When the broken slab extends over 2 ft. enough is taken out for a new concrete slab.

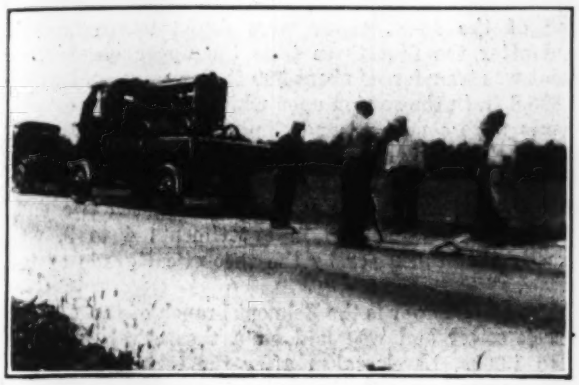


FIG. 4—TRUCK CARRIES COMPRESSOR AND PATCHING MATERIAL

The outfit used for repairing blow-ups is shown by Figs. 4 and 5. It consists of a truck, a portable compressor and pneumatic and hand tools. The compressor is run onto the truck for shifting it from job to job. The truck also carries 1½ tons of Amiesite. A regular pneumatic hammer with a bull-point tool is used for cutting the concrete. Two men are required. The daily cost of operation is about as follows: Two men, $7; truck and compressor rental and operation $20, and 1½ tons of Amiesite $18; or a total of $45. With the work available, an outfit can make four normal repairs in a day.

FIG. 5—CUT MADE WITH PNEUMATIC TOOL AND BULL POINT

The repair of blow-ups is handled by the regular maintenance department crews under the division engineers. C. D. Buck is state highway engineer of Delaware.

Effect of Berms on Flow in Alamo Canal

By G. G. Sypes
Imperial Irrigation District, Andrade, Calif.

IMPERIAL VALLEY irrigation is supplied by water taken from the Colorado River at Andrade, Calif., about a mile above the Mexican line, and conveyed about 70 mi. to the point of use through the Alamo Canal. Part of the canal consists of the channel of the old Alamo River, the remaining portion having been formed by dredging. The volume flowing in the main canal varies from 2,000 sec.-ft. in winter to about 7,500 sec.-ft. during periods of intensive irrigation in summer. This large variation makes the regulation at the point of intake an important feature. An up-to-date gaging station is situated on the canal about one mile below the point of intake. Here frequent discharge measurements are made with a small Price current meter. No stable control exists below this station, and the bottom movement is considerable, so that regulation requires careful study and watching.

For a large range of stage it is found that a change of 0.1 ft. on the gage results in a change of about 100 sec.-ft. This is a convenient fact, and considerable use is made of it in regulating the flow. At certain stages, however, this otherwise more or less stable relation seems to break down entirely. At one point on the gage, which has been termed the critical stage, this is particularly so. There are no apparent bottom or velocity changes at such times at the gaging section. The following is given as a possible explanation of what occurs at the critical stage:

The canal banks are lined for many miles with willow, arrow weed, tule and other native brush. The lower extremity of this brush lies fairly well in a plane. Many of the roots tend to spread out horizontally, and the silt collects round them and forms a sort of berm. Once a berm has started its formation seems to be accelerated both by accumulation of silt around and among small plants which gain a foothold on the berms at low water and by the caving of high banks, the resulting debris of which tends to extend the berms farther out into the stream. These berms, at many places on the canal, are very pronounced and seem to be nearly horizontal.

Consider the water level in the canal to be such that the berms are just uncovered. Now suppose an increase of 500 sec.-ft. is called for. The water level rises about 0.6 ft. and covers the berms. This increases the wetted perimeter appreciably, which results in a rapid decrease of the hydraulic radius. According to the Chezy formula, $V = c\sqrt{RS}$, a decrease in the hydraulic radius will result in a corresponding decrease in the velocity. The discharge, therefore, does not increase in the same relation to gage height as before the berm was reached.

Observation has shown the point of breakdown in flow relation or the critical stage, to correspond fairly well with the position of the berms.

This may not entirely explain the case in point but it undoubtedly has bearing upon it. Since the Alamo is more or less typical of many Western canals, it is hoped that it will be of interest to those concerned.

Determinations of Kutter's *n* in 15- and 18-In. Pipe Sewers

Tests on Sewers in Cambridge, Mass., Built in 1893 Show *n* of 0.011 to 0.020 and Indicate General Use of 0.015 for Kutter's *n*—Sewers Tested Represented Normal Conditions

By Charles W. Sherman
Of Metcalf & Eddy, Consulting Engineers, Boston, Mass.

In *Engineering News-Record* of June 8, 1923, the writer called attention to the fact that comparatively few experimental data on flow of sewage in sewers, and particularly in pipe sewers, were available, and that values of Kutter's *n* used in computing flow in sewers were based almost wholly on experimental determination on water conduits or on laboratory tests, in which comparatively clean water was used. At the time the paper was written the only experimental data on pipe sewers which the writer had been able to discover were the tests of T. Chalkley Hatton on a 24-in. vitrified pipe sewer at Carlisle, Pa., reported in "American Sewerage Practice," Volume 1, and an outline report of certain tests on sewers at Seattle, Wash., by H. D. Silliman, reported in *Engineering News*, Dec. 2, 1915. Since that time data obtained from tests of three outfall sewers of Phoenix, Ariz., have been reported by S. M. Cotten in *Engineering News-Record* of Oct. 16, 1924, which showed values of *n* of 0.0111, 0.0117 and 0.0125 for the 24-, 30- and 36-in. sewers, respectively, when there was "a good depth" in the pipes.

The available information being so slight in amount and inconclusive, Metcalf & Eddy obtained permission from the Metropolitan District Commission of Massachusetts, through F. D. Smith, chief engineer of the sewerage works, to make experiments on the flow in some of its pipe sewers. Sections were found where considerable lengths of sewer existed on uniform grades, nearly straight in alignment, and without branches contributing additional sewage. Of seven conclusions based on these experiments given at the close of this article the one of most general applicability is that as a rule *n* should be taken at not less than 0.015 in sewer pipe design.

Description of Sewers Tested—The 18-in. sewer is the Cambridge branch of the Alewife Brook sewer and was built in 1893. The section tested is 2,426.6 ft. long, in which there are 12 manholes, not including those at the ends of the section. The theoretical grade is 1 in 1,200 or 0.000833. One branch enters the sewer at about the middle of the reach which formerly carried the sewage from a slaughter house. It now serves a metal manufacturing plant from which the flow is so small as to be negligible and the branch is therefore of no consequence.

There is deflection in alignment at five manholes in the reach under consideration as follows: 3 deg. 16 min.; 0 deg. 42 min.; 1 deg. 21 min.; 12 deg. 13 min.; 12 deg. 2 min. These deflections are so small that it is believed that their effect on flow is insignificant.

This sewer is laid largely through water-bearing sand, in some places mixed with considerable amounts of clay, and parallels a brook for its entire length at a distance varying from 10 to 50 ft. The amount of ground water leaking into the sewer at the time of the test was, however, insignificant as shown by inspection.

As will be noted below, the conditions in the upper end of the 18-in. sewer were found unsatisfactory, and after the first three tests the upper observation point was transferred about 580 ft. downstream, leaving 1,835.8 ft. in the section upon which the further experiments were conducted and eliminating the first deflection angle. In this section there were nine intermediate manholes. Levels run shortly after the tests showed that the difference in elevation between the two ends of the section, included in experiments 4 to 9, was exactly that called for by the theoretical grade of the sewer.

The 15-in. sewer is the Belmont branch of the Alewife Brook sewer and was laid on a theoretical grade of 1 to 1,000. Levels taken after the tests showed the actual slope in the section 0.27 ft. less than that called for by the profile, the actual slope being 1 in 1,120 or 0.000891. The section tested was 2,458.9 ft. long and contained no branches. There are nineteen manholes within this section, at six of which there are deflections in alignment as follows: 0 deg. 15 min.; 2 deg. 31 min.; 2 deg. 30 min.; 2 deg. 30 min.; 3 deg. 57 min.; 0 deg. 18 min. This sewer is laid largely through swampy land and immediately adjoins the toe of a railroad embankment. For about one-third of its length the sewer is supported on piles. Inspection immediately after the test showed a very small amount of ground water leakage, possibly amounting to 2 or 3 per cent of the normal sewage flow

Condition of the Sewers—It is the practice of the Metropolitan Sewerage Works to clean the pipe sewers usually twice a year, using wire brushes pulled through by rope. At the time of the tests the sewers had not been cleaned for several months. The conditions may therefore be assumed as fairly representative of reasonably well kept sewers under normal conditions, not perfectly clean nor with such accumulations as would exist in sewers which received little attention.

As noted above, the upper end of the 18-in. sewer was found to have a considerable deposit of sludge and sand, varying in some places from 2 to 4 in. in depth. The effect of including this section is shown in the comparatively high value of *n* obtained in experiments 1 to 3. This condition, however, was not representative of the sewer as a whole and the later experiments were made in a section of the sewer in which conditions were substantially uniform and but little deposit existed. What there was consisted of sand with a maximum depth of perhaps 2 inches.

Filamentous fungi could be seen hanging from the top of the sewer but for the most part not reaching the water surface when the flow was about one-half the depth of the sewer, although there were a few spots where larger growths caused some disturbance of the flow. At one spot there was an obstruction, probably caused by a deposit in the sewer, which resulted in a drop in the water surface of about 1½ in. At one

point, too, a short section of the pipe had settled below grade, the maximum settling being about 6 in. For the most part, the joints appeared even and smooth, but there were a few cases where a little mortar could be seen projecting from the joints. The benches in the manholes are approximately at the elevation of the center of the pipe. As the experiments were made when the depth of flow slightly exceeded half the diameter there was a slight disturbance of the flow in passing through the manholes.

The 15-in. sewer was in somewhat better condition than the 18-in. There was less deposit in the sewer and, although there were a few places where filamentous fungi could be seen, at no point did they reach the surface of the water in the sewer. At one point there was an obstruction causing a drop in the water surface of about 3 in. and at another point a similar obstruction with the drop of about 1 in. At one point this was diluted at the point of application in the proportion of about 1 to 30. One quart of the dilute solution was used for each experiment. The dye was poured into the water as quickly as possible, probably within less than 1 sec. and the time of application was noted. At the lower station the time when the dye was first noticeable was reported and the time when it could last be detected was also recorded. It was first apparent as a faint pink color, increasing in intensity for 15 or 20 sec., maintaining a distinct red color of apparent uniform intensity for about 1 min., and gradually fading away for perhaps 30 or 40 sec. To assist in detecting the color, a bright metal plate was suspended in the sewage an inch or two below the surface. The use of the dye was entirely satisfactory. In the 18-in. sewer the time interval between the appearance and disappearance of the color ranged from 1 min. 50 sec. to 2 min. 10 sec. In the 15-in. sewer

DETERMINATIONS OF N IN 18- AND 15-IN. VITRIFIED PIPE SEWERS AT CAMBRIDGE, MASS.
Experiments by Metcalf & Eddy, Nov. 1, 1923

Experiment No.	Length of Sewer, Ft.	Slope of Water Surface	Av. Depth of Flow at Ends of Section, In.	Diff. in Depth at Ends, Ft.	Ratio of Depth to Diameter	Radius R Ft.	Time of Flow Sec.	Velocity Ft. per Sec.	C in Chezy Formula	n in Kutter Formula
18-In. Pipe—Cambridge Branch of Alewife Brook Sewer										
1	2,426.6	0.000874	11½	0.10	0.653	0.433	1,505	1.610	86.8	0.0149
2	"	"	11 11/16	0.10	0.649	0.431	1,503	1.615	83.2	0.0148
3	"	"	11 11/16	0.10	0.649	0.431	1,503	1.615	83.2	0.0148
4	1,835.8	0.000838	9 11/16	0.01	0.537	0.392	1,103	1.665	91.8	0.0134
5	"	0.000838	9 11/16	0.01	0.545	0.396	1,105	1.661	91.2	0.0135
6	"	0.000844	9½	0.02	0.548	0.397	1,108	1.657	90.5	0.0136
7	"	0.000844	9½	0.02	0.548	0.397	1,110	1.654	90.4	0.0136
8	"	0.000849	9 11/16	0.03	0.545	0.396	1,108	1.657	90.4	0.0136
9	"	0.000849	9 11/16	0.03	0.545	0.396	1,110	1.654	90.2	0.0136
15-In. Pipe—Belmont Branch of Alewife Brook Sewer										
10	2,458.9	0.000907	7¼	0.04	0.475	0.302	1,495	1.644	99.4	0.0120
11	"	0.000911	7 5/16	0.05	0.470	0.300	1,485	1.655	100.1	0.0119
12	"	0.000915	7¼	0.06	0.475	0.302	1,498	1.641	98.8	0.0121
13	"	0.000920	7 5/16	0.07	0.479	0.304	1,496	1.643	98.3	0.0121
14	"	0.000915	7¼	0.06	0.475	0.302	1,503	1.636	98.5	0.0121
15	"	0.000915	7¼	0.06	0.475	0.302	1,513	1.625	97.7	0.0122

Note: There was a barely perceptible movement of air in the sewers in the direction of flow during most of the experiments. Both sewers were in fairly good condition, but had not been cleaned for several months. Experiments 1-3 included a section in which there were considerable deposits.

also, three or four lengths of pipe had settled below grade to a maximum depth of 6 or 7 in. The depth of flow when the experiments were made was a little below half the diameter of the pipe so that the water did not spread out in the manholes and no interference with the flow resulted from this cause.

Method of Making Tests—In order to determine the value of n in the Kutter formula it is necessary to determine the velocity of flow, the hydraulic slope, and the value of the hydraulic mean radius, R. If the flow had been at a uniform depth in the sewer, the hydraulic slope would be that of the invert which was determined by leveling as noted above. During the tests the depth of flow at each end of the reach tested was determined at frequent intervals by measuring with a rule. Changes in depth were very gradual and noticeable difference in depth did not occur in less time than 10 minutes. The hydraulic slope used in the computations has been taken as the difference in elevation of the water surface at the two ends divided by the length of the section. Drops due to obstructions in the sewer or changes in slope at sags in grade have been disregarded.

The value of R has been computed on the assumption of an average wetted section corresponding to the mean of the depths measured at the two ends, assuming the pipes to be perfectly circular.

The velocity was measured by noting the time of passage of a dye thrown into the sewer at its upper end. A solution consisting of ½ lb. of eosine dissolved in 1 qt. of water was made up in the laboratory, and the range was from 2 min. 10 sec. to 2 min. 20 sec. In every case the mean between the time of appearance and disappearance of color was taken as representative of the time of flow in the sewer.

Results of Experiments—The accompanying table shows the results computed from these tests. The value of Kutter's n for the 18-in. sewer was found to be 0.0135 and for the 15-in. sewer 0.0120. In view of the greater cleanness of the 15-in. sewer and the fact that the manholes caused no disturbance in this line, while they did slightly affect the flow in the 18-in. sewer, these results are believed to be consistent.

The value of 0.0148 for n in the 18-in. sewer obtained in experiments 1, 2 and 3 shows the effect of the considerable deposits in about 580 ft. of the upper portion of this sewer and indicates that the coefficient in this section was probably in excess of 0.018.

Conclusions—It is believed that these experiments justify the following conclusions as applicable to sewers of 15- and 18-in. vitrified pipe, with the pipes about half filled, and velocities between 1.5 and 2.0 ft. per sec. The writer believes that in the absence of information to the contrary, the same conclusions may be assumed to apply to all sizes of vitrified pipe, for depths of flow ranging between one-third and full depth, and for velocities between 1 and 5 or 6 ft. per second.

(1) In straight sections of vitrified pipe sewers in good condition and nearly clean where no disturbance in flow results from enlargements at the manholes, or from the entrance of branch sewers, a value of $n = 0.012$ may be expected.

(2) In similar sections immediately after cleaning, n would probably be 0.011.

(3) When slightly greater deposits have accumulated in the sewer and when roots have attained sufficient size to begin to affect the flow in the sewer and there is some disturbance at manholes resulting from the water spreading over the benches, the coefficient n may be about 0.0135.

(4) Where there are considerable deposits of sand and sludge in the sewer and the disturbance at manholes is more marked, n may reach 0.018 or 0.020.

(5) A greater depth of flow than those observed during the experiments would have resulted in considerable disturbance at each manhole with corresponding increase in the value of n. The experiments of Yarnell and Woodward (Bull. 854, U. S. Dept. of Agr.) referred to at some length in the writer's article in *Engineering News-Record* of June 8, 1922, indicated that in general a somewhat greater value of n existed for pipes flowing partially full than for the same pipes substantially full. While this may be the case when the pipes are continuous without enlargements at manholes, it would not hold true for sewers as ordinarily constructed in which there was an appreciable enlargement with corresponding loss of head at each manhole when sewage is flowing at a greater depth than half the diameter of the sewer.

(6) The use of the coefficient $n = 0.013$ in the design of pipe sewers is justified only when the sewers are cleaned with sufficient frequency to avoid the accumulation of material amounts of deposits; when the manholes are so constructed as to avoid appreciable disturbance of the flow; and when changes of direction sufficient to cause appreciable resistance or other conditions impeding flow are absent.

(7) When allowance for deposits and for resistance to flow resulting from enlargements at manholes, changes of direction, entrance of branches, etc., must be considered, a value of n not less than 0.015 should be used in design. Since these factors are rarely absent, this value should generally be used.

A Plan for a Metropolitan Water District in New Jersey

Clemens Herschel Proposes a State Commission to Succeed Present District Commission—Also State Bond Issue

A FINANCIAL and administrative plan to enable the communities of northeastern New Jersey to provide themselves with an adequate water supply has been drawn up by Clemens Herschel, past-president American Society of Civil Engineers, and submitted to the commission created by the New Jersey legislature to formulate a comprehensive water-supply policy for the state. The commission includes one engineer, Carroll P. Bassett, of Summit. Mr. Herschel has resided at Glen Ridge, N. J., for many years.

Mr. Herschel's plan is embodied in drafts of two proposed legislative acts, prefaced by a satement of the need for action to insure a water supply and an exposé of the bungling, circumlocutory method employed during past years to overcome a constitutional barrier to efficient direct action, which barrier, he contends, would be overcome by the proposed acts. The barrier is a constitutional prohibition of the issuance of state bonds in excess of $100,000 unless approved by a state vote and the bungling circumlocutory method described by Mr. Herschel was the creation of a commission with no funds or powers except as derived through contracts with the individual municipalities for which works were to be built. Or, as Mr. Herschel picturesquely states, the "legislative draftsman, fertile in expedients, though possibly unappreciative of topography and its demands upon water supply and sewerage construction matters, and having in an unguarded moment possibly scant regard to considerations of resultant business economies, and 'we will use the credits of the several municipalities. They shall form a sort of partnership, and a commission shall be the agent of this loose, riotous and recalcitrant form of partnership.'" Continuing Mr. Herschel says: "Thus was formed in 1902 the Passaic Valley Sewerage Commission, which took at least three times as long to build its works—the commission could not help it, under its imperfect powers and organization—than it should have taken; and consequently also spent on the works it built, I have no doubt, at the least twice the money that such works should have cost."

So far as water supply is concerned, Mr. Herschel's "way out," as provided in his proposed acts, is (1) to create a "Metropolitan Water Supply District of the *State* [italics ours] of New Jersey," to consist "of all municipalities wholly or partly within" 20 miles of a named point on the Jersey City water front, and a commission of "three skilled and competent men," to be appointed by the governor, with the approval of the Senate, the commission to be authorized to supply water at wholesale to municipalities or companies within the district, and to build works, condemn property, buy out companies, etc.; and (2) to have the State of New Jersey, if the people of the state so vote, issue $50,000,000 of state bonds, not over $10,000,000 in any one year, to finance the district water-works, the capital charges and operating expenses to be annually assessed by the state authorities against each community supplied, according to the amount of water it has taken during the year. Existing supply works of communities entering into the new supply scheme would be taken over by the district, with proper compensation. Municipalities within the district would be compelled to take water for domestic purposes from the district unless specifically exempted from doing so by the legislature. No town now supplied by a company owning the distribution system in the town could contract with the district until it had acquired the works of the company.

The new commission proposed by Mr. Herschel would succeed the North Jersey District Water Supply Commission, which is now building works to supply Newark and other communities from the Wanaque River. The commission before which Mr. Herschel has laid his plan is to report to New Jersey Legislature in January, 1926.

Hydro-electric Power in Italy

Italy, on account of a lack of fuel, has turned to the development of water power. There are many falls already developing upwards of 10,000 hp. and the total actually installed is now 2,275,000 hp. or practically 40 per cent of the 5,500,000 hp. which it is estimated the streams of the country could produce. The greatest development is in Lombardy in North Italy. In 1898 the installed horsepower was only 115,000 and in 1908 it was 552,000. By 1928 it may exceed 3,000,000 hp.

U. S. Navy Dirigible "Shenandoah" Destroyed by Storm

American-Built Rigid Airship Breaks Apart and Falls to Ground in Ohio Thunderstorm—Nature of Failure Unknown—Ship Not Built to Withstand Thunderstorm Winds—Changes in Construction

ABOUT 5 a.m. Sept. 3 the dirigible *Shenandoah*, of the U. S. Navy, was wrecked and broken up while passing through a thunderstorm near the village of Ava, 25 miles east of Zanesville, in southeastern Ohio. The ship broke in three parts; the main (rear) portion settled to the ground almost at once, its framework being partly crushed in the fall (see adjoining views), the short middle section fell nearby, while the bow portion drifted about 12 miles before it was brought to ground by the men aboard. The control car, suspended under the center line of the ship near the bow, and several of the engine cars suspended farther back (see a drawing of the ship reproduced herewith) broke away either before or during the failure of the hull and fell to the ground. The commander and all others who were in the control car were killed, these and the other deaths bringing the total list of fatalities to 14.

The *Shenandoah* was engaged on a cruise to St. Louis, Minneapolis and other points in the Middle West, the round trip being intended to cover five or six days. It had left Lakehurst about 4 Wednesday afternoon, Sept. 2, and according to the ship's log had fair weather and good navigating conditions until it reached the Ohio River in the vicinity of Wheeling, W. Va., at 1 or 2 in the morning. Sailing thence in the direction of Zanesville, the vessel met heavy winds, according to survivors, and apparently ran constantly deeper into a violent storm. Just before its end it rose suddenly from a height of about 3,000 ft. above ground to twice that height, then dropped even more suddenly about the same distance, part of this time was inclined on a steep pitch and seemed to be standing on end, and then was seen by people on the ground to be broken into a V-shape, separating into three pieces shortly thereafter. The lines of separation of the frame were in the neighborhood of 90 m. and 130 m. from the bow, as nearly as can be learned from the facts so far available. The control car and forward wing cars fell at an early period in the breakup. Most of the deaths were due to the falling of these cars.

None of the sections of the wreck took fire, although much gasoline was scattered about. The gas cells contained helium in place of the inflammable hydrogen.

One or more of the ship's motors developed bearing trouble shortly before the accident, according to survivors' reports. This was presumably due to forced full-power running in the attempt to escape the heavy weather through which the ship had worked for several hours.

Diagonal Wires Found Parted—Broken diagonal wiring was reported to the Secretary of the Navy by Rear Admiral C. W. Dyson on Sept. 7, apparently with the suggestion that this may have been the cause of the failure of the hull. No other fractures of hull parts have been identified as primary, nor have the stories of survivors given a basis for attributing the wreck to the failure of a particular part of the structure.

One of the crew says that while the ship was in almost vertical position, but still entire, gasoline tanks broke from their guide supports along the keel passageway and skidded down through the framework of the ship, breaking members of the hull on their way and so initiating the failure. Others report tearing loose of the control and engine cars as the first event, and it has been suggested by naval men that the hangers and stays which held these cars were not strong enough for positions of steep pitch.

Structural and Equipment Changes—An important change in the gasbag equipment was made a short time ago, by the removal of eight of the automatic gas-release valves, leaving the bags connected, however, to provide an automatic vent for every part of the buoyant system but with discharge area of the whole system reduced by one-half. Capt. A. Heinen, former consulting engineer of the Navy and one of the early navigators of the *Shenandoah*, has pointed out that this change involved the danger of gas cells bursting from excess pressure in case the ship rose suddenly by a considerable height; and he has suggested that the bursting of one or more cells after the rise already mentioned caused a break-in-two of the hull. Calculations cited below indicate that the change of loading due to deflating one or more cells produces very serious bending stresses in the framework.

Installation of new apparatus for recovering condensation water from the engine exhaust to balance the loss of weight by gasoline consumption has also been mentioned as a source of danger to the ship. The change is said to have involved greater concentration of load than the original system, and also to have required cutting and splicing one or more frames.

Other changes, it is reported, included removal of the forward motor, located just behind the control car, to enlarge the radio room. After this change the ship operated with five of the original six motors.

The *Shenandoah* was built by the U. S. Naval Aircraft Factory, the fabrication work being done at League Island Navy Yard, where the factory is located, and the assembly at the Naval Air Station at Lakehurst, N. J. While building, the ship was known as the ZR-1.

Size and Structure of Airship—From an article "Building the Navy Airship ZR-1," published in *Engineering News-Record* of Aug. 9, 1923, p. 212, just as the vessel was approaching completion at Lakehust, N. J., the following facts concerning the size and structural nature of the ship are abstracted:

In general shape the vessel was cigar-like, as shown by the drawing Fig. 1, with a length of 680 ft. (207.8 m.), and diameter of 79 ft. (24 m.) at midsection. It was composed of ringlike transverse frames (Fig. 2) 32.8 ft. (10 m.) apart, with lighter, intermediate rings halfway between the main frames, all connected by 13 lines of main longitudinal struts and subsidiary longitudinals between these, and a double system of crossed diagonal wire braces in the peripheral surface. Each main frame was braced in its own plane by a large number of diametral and chord wires, (Fig. 2), but the intermediate frames were not so braced. The structural hull was enclosed by two sets of netting to resist the outward pressure of the gas cells, this netting being (except in the lowest part of the

vessel) in the plane of the inner surface of the main frame members. The two netting inclosures were, respectively, a cord netting of 9-in. mesh and a steel netting of crossed diagonal wires 18 in. apart. In the lower part of the ship, where the frames were modified to provide for the keel passage, the layers of netting deflected upward to pass over this space. The entire exterior of the ship was covered with impregnated fabric, applied in longitudinal strips laced to the frame members along their edges, and the joint spaces covered with other strips of fabric cemented on, the entire skin being finally brush-coated with cellulose acetate.

At the tail of the ship there were fixed vertical and horizontal fins, and connected with them movable rudder sections.

In each space between main frame rings there was a gas cell, having the full diameter of the ship and a length of 10 m. An axial hole through all the gas cells provided for passage of a central cable extending from bow to stern of the ship. The endwise pressure of the gas against the flat end walls of the cells balanced throughout the length of the ship and was resisted by the axial cable when all the cells were full, while when one cell was deflated the endwise gas pressure of the adjacent cells was resisted by the transverse brace wires of the main frames.

Six motors in cars hung below and off the bilges of the vessel furnished the means of propulsion. The forward motor was in a compartment just back of a separately suspended control car, from where all the rudders, gas valves and similar controls were handled. Apparently this forward motor had recently been removed in order to enlarge the radio room just back of the control room.

Gasoline tanks and ballast bags were hung along the sides of the keel gallery. Provision was made for releasing the water ballast and some of the fuel tanks when necessary to lighten the ship.

Material—The entire metal framework of the ship (except diagonals and bracing wires, which were steel) was constructed of duralumin, an alloy of aluminum and copper of about 2.8 specific gravity. The members of the structure were triangular (a few rectangular) latticed struts, made up of corner members of deep channel outline formed of thin sheet metal connected by stamped ribbed lattice bars of similar sheet metal, assembled by cold riveting with duralumin rivets. The principal sections were 1.358 in. wide across flanges and 0.709 in. deep, by 0.039 to 0.055 in. thick, for the larger channel; 1.18 in. wide by 0.59 in. deep, by 0.031 to 0.079 in. thick, for the smaller channel, and for certain angle sections 0.835 in. wide (across outstanding tips of the legs) by about 0.75 in. deep (at right angles to this dimension) by 0.039 to 0.063 in. thick. The triangular girders, as assembled, ranged in size from base width of 6.91 in. and height of 7.902 in. to base width of 11.394 by height of 14.154 in. The rivets ranged from 0.0965 in. to 0.154 in. diameter.

The material had the following composition, determined from several hundred analyses of specimens:

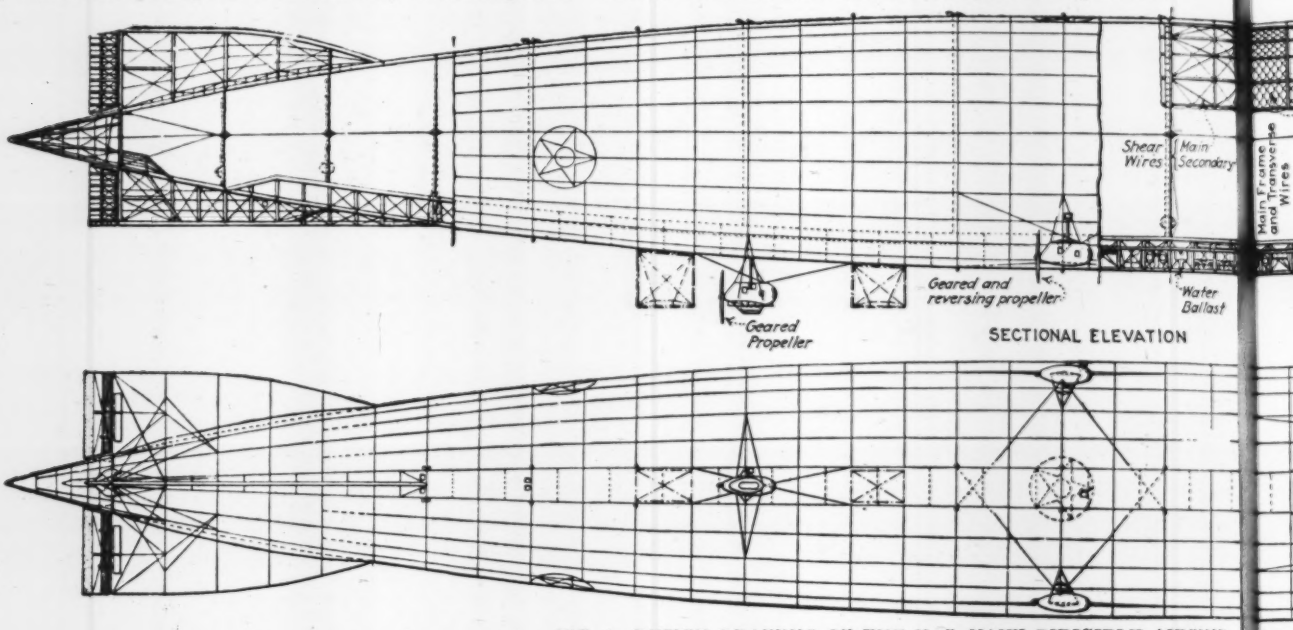


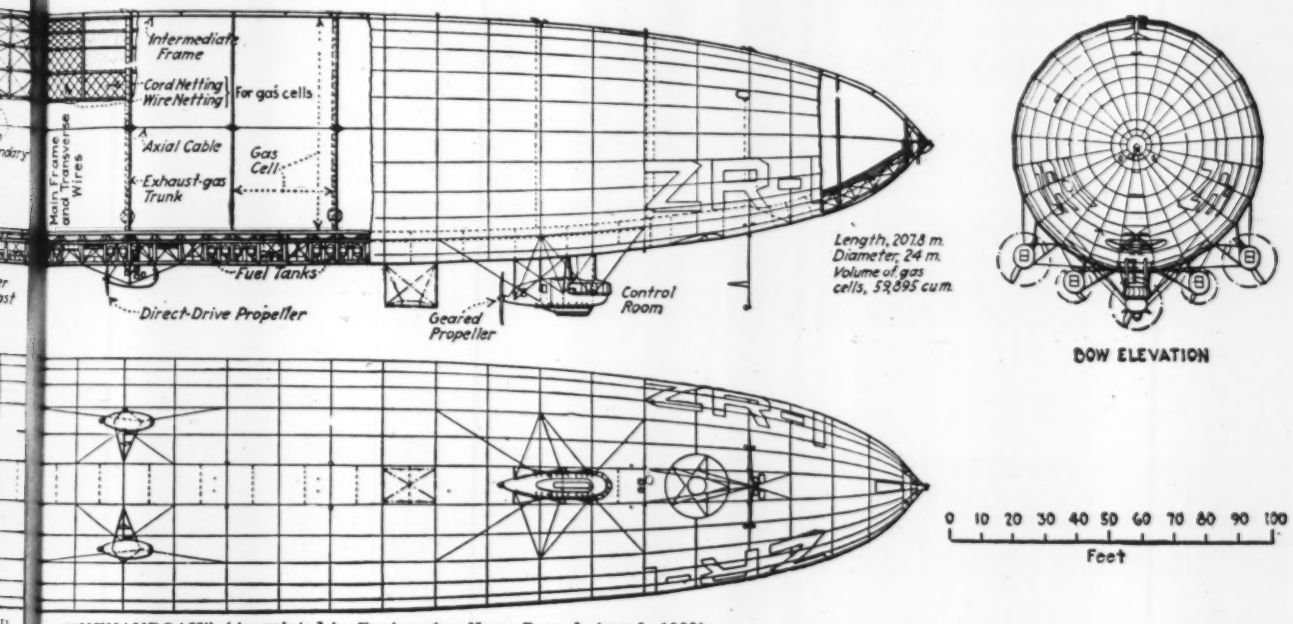
FIG. 1—DESIGN DRAWING OF THE U. S. NAVY DIRIGIBLE AIRSHIP

Cu 4.23 per cent, Mg 0.54 per cent, Mn 0.52, Fe 0.45, Si 0.26, Al 94.20 per cent. Tensile tests on over 1,000 specimens showed an ultimate strength of 40,000 to 60,000 lb. per square inch (90 per cent of the specimens 55,000 to 60,000 or over), elastic limit 35,000 and over; elongation 16 to 22 per cent, measured on a test specimen ½ in. wide (90 per cent of the specimens 18 per cent or over). The endurance limit of the material in alternate bending and endurance tests at the Bureau of Standards ranged from 15,000 to 20,000 lb. per square inch.

Design, Loads and Stresses—The only published statement of the theory and assumptions underlying the design of the *Shenandoah* is contained in a paper "The Strength of Rigid Airships," delivered by the designers of the vessel, Commander J. C. Hunsaker, C. P. Burgess, and Starr Truscott, before the Royal Aeronautical Society (England) a year ago and published in the society's *Journal* of 1924. The design is stated by the authors to be virtually a precise copy of the design of a Zeppelin which came down in France in 1918, but reanalyzed and somewhat strengthened.

Tests made on the structural members of the ship quoted by the authors, showed that the strength of the riveted struts as columns was 15,000 to 23,000 lb. per sq.in., averaging 18,000, for moderate length-ratios, and on longer lengths followed the Euler formula with modulus of elasticity about 10,000,000 lb. per sq.in. About 150 of the members were tested. In bending, ultimate strength of 18,000 to 27,000 lb. per sq.in. were reached, averaging 22,000, and in combined bending and compression about the same ultimate stress was found.

The strength of the ship is controlled less by its dead weight than by dynamic forces set up in flight. The moderate nature of the loading may be appreciated from the fact that the entire framework weighs only 15 tons. Under normal distribution of the loads in the vessel, the maximum bending moment, as reported by Hunsaker, Burgess and Truscott, is about 100,000 meter-pounds (m.-lb.); the moment may be doubled by unfavorable load distribution, and multiplied threefold



"SHENANDOAH" (As printed in *Engineering News-Record*, Aug. 9, 1923)

when one gas cell is deflated and the adjacent ones half deflated. The maximum bending moments in normal condition are hogging, while those due to a deflated gas cell are sagging, the change representing a total change of 358,000 m.-lb., equivalent to 7,900 lb. per square inch change of stress in the top longitudinal, "so that," the authors state, "a deflated gas cell can cause severe stresses, and great care must be exercised in operating under such conditions."

In calculating the aerodynamic forces as affecting the longitudinal strength of the ship, the authors state that five conditions were considered: (1) sudden application of rudders and elevators at 20 deg. throw when the vessel is proceeding at full speed; (2) flying the ship light or heavy by running the elevators at a fixed angle of pitch; (3) turning at 2,114 ft. radius and forward speed of 85 ft. per second; (4) flying in heavy weather; (5) lying to a mooring mast. The moments computed for these conditions are tabulated below.

As to Storm Stresses—The authors state that severe weather conditions may produce stresses far beyond the reach of analysis. They, therefore, arbitrarily adopt certain assumptions as to maximum weather conditions: the ship running at a speed of 86 ft. per second into an uprushing current of air of 3 m. per sec. This has the effect of a 6 deg. yaw or pitch at the same forward speed, and produces a bending moment of 318,000 m.-lb., which, say the authors, "is the greatest bending moment found in our calculations."

In discussing this matter of storm stresses the authors make some significant statements, the following being typical:

> The rigid airship, being of great size and delicate construction, should be operated with due consideration of the weather. . . .
>
> From a general survey of existing meteorological data, it seems clear that the winds inside a well-developed cumulus cloud are of great violence and present a real menace to an airship. . . . An airship running into such a cloud will experience a sudden and violent force. This force seems entirely impossible to calculate, and cumulus clouds should be considered a warning of danger and should be avoided. . . .
>
> The turbulence of air flowing over rough ground, which is felt as gustiness, is too highly complex to lend itself to exact measurement or general definition. We have concluded to omit a strength calculation for the case of a ship running at full speed through a gusty surface wind. . . .
>
> The existence of veritable fountains of upward rushing air, whose sides at times and places are sharply separated from the surrounding atmosphere, must be taken account of. . . . The thunderstorm with large, full-developed cumulus tops is also conspicuous and avoidable. It would appear to be folly to enter such a cloud and subject the ship to the unknown dangers of wind, rain, hail, and lightning. Barring such spectacular and presumably avoidable hazards as these, there remain, at flying altitudes, convection currents with attendant turbulence, which the ship may run into at full speed. There is ample evidence that upward velocities as high as 3 m. per sec. will be encountered. This . . . will give the effect of a change in pitch of 6 or 7 deg.

It is the last-stated condition for which they made the calculation noted above, showing a bending moment of 318,000 m.-lb.

Thus, the design of the ship, while making provision

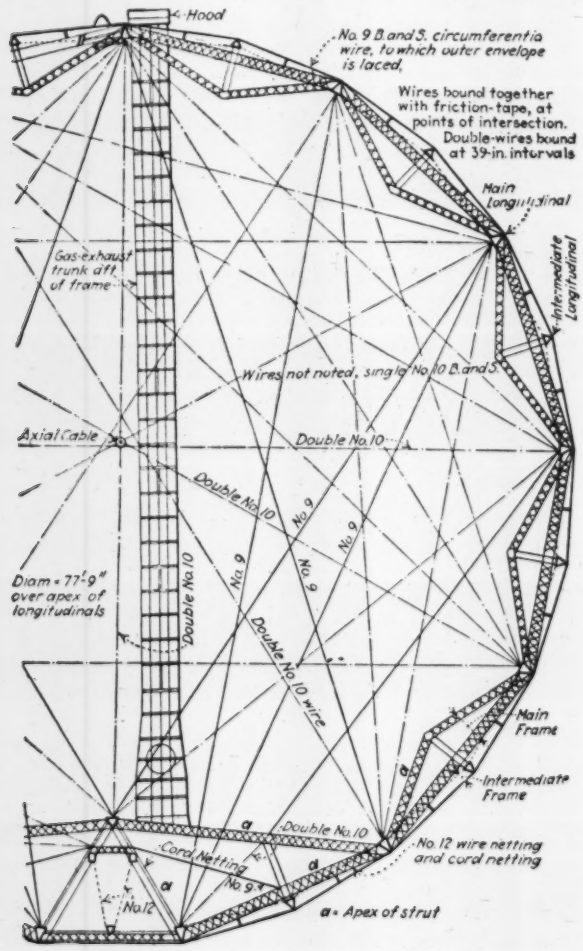

Hood
No. 9 B. and S. circumferentia wire, to which outer envelope is laced.
Wires bound together with friction-tape, at points of intersection. Double-wires bound at 39-in. intervals
Main Longitudinal
Intermediate Longitudinal
Gas exhaust trunk aft of frame
Wires not noted, single No. 10 B. and S.
Axial Cable
Double No. 10
Double No. 10
No. 9
No. 9
No. 9
Diam = 77'-9" over apex of longitudinals
Double No. 10
No. 9
Double No. 10 wire
Main Frame
Intermediate Frame
a
Double No. 10
No. 12 wire netting and cord netting
Cord Netting
No. 9
No. 12
a = Apex of strut

FIG. 2—MAIN TRANSVERSE FRAME

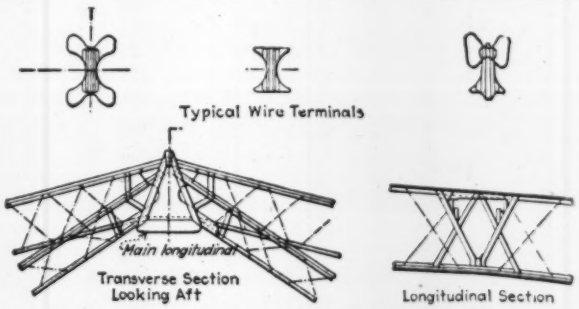


FIG. 4—TYPICAL FRAME JOINT OF SHENANDOAH

for certain assumed conditions of weather, did not attempt to provide for running at full speed through gusty surface winds or running through the wind which may exist in the heart of a violent squall or storm.

Factor of Safety—The authors summarize the maximum bending moments (longitudinal) in the hull of the ZR-1 in the table in column 2.

In combining the moments for maximum conditions, the authors point out that the condition of one gas cell deflated and the ship then running into a gust would produce a maximum bending moment of 595,000 m.-lb., giving a compressive stress of 13,400 lb. per sq. in. in the top longitudinal. In addition there would be 11,000 lb. per sq.in. stress in the apex channel of this member from the gas pressure and from secondary bending, making the total stress in the member 24,400 lb. per sq.in. This, they conclude, would give a factor of safety of only 1.1 when applied to the test strength of about 27,000 lb. per sq.in. which they say was found. They therefore say, "With a deflated gas cell an airship should never be driven at full speed even in still air, so that this condition may be considered as too severe for a fair estimate of the real factor of safety."

MAXIMUM BENDING MOMENTS, LONGITUDINAL, IN HULL OF ZR-1

	Meter-Pounds
Static Bending Moment	
Full load, best conditions	97,500
Full load, unfavorable conditions	196,300
Light load	187,000
One deflated gas cell	277,000
Dynamic Bending Moment	
6 deg. pitch at 68 ft. per sec. velocity	199,000
12 deg. pitch at 48½ ft. per sec. velocity	199,000
6 deg. pitch at 86 ft. per sec. velocity (running into a gust)	318,000
Sudden application of the rudders at 20 deg. at 86 ft. per sec. velocity	107,000
Steady turning at 2,114 ft. radius at 85 ft. per sec. velocity	230,000
Lying to mooring mast in steady wind at 88 ft. per sec. velocity	130,000

Assuming, therefore, that the operation of the vessel is limited to safer conditions, the authors compute a maximum compressive stress in the longitudinals under the greatest sagging moment of 16,000 lb. per sq.in., and a maximum stress under the greatest hogging moment of 15,000 lb. per sq.in., representing factors of safety of 1.68 and 1.82 (for assumed strength of

FIG. 3—VIEW OF STERN PORTION OF "SHENANDOAH" AS IT FELL

27,000; but see the test figures quoted on p. 439). The transverse frame showed a factor of 1.21 (for deflated cell).

Rigid Dirigibles Compared—"These factors of safety may appear low," they state, "but the ZR-1 compares favorably in strength with successful British and German airships." (See adjoining table.)

Reinvestigation of Design—While the ZR-1 was under

DATA FOR FIVE RIGID AIRSHIPS

	ZR-1	L49	L72	R33	R38
Area of longitudinal girders, sq.mm.	4,960	4,830	4,872	5,260	4,803
Diameter, meters	24.0	24.0	24.0	24.0	26.0
Section modulus, ft. x in. 2.	139.9	135.9	138.6	144.0	154.0
Maximum bending moment, light condition, m.-lb., hogging	188,500	211,000	.....	236,000	166,000
Maximum stress, light condition, hogging	4,450	5,140	.....	5,190	3,540

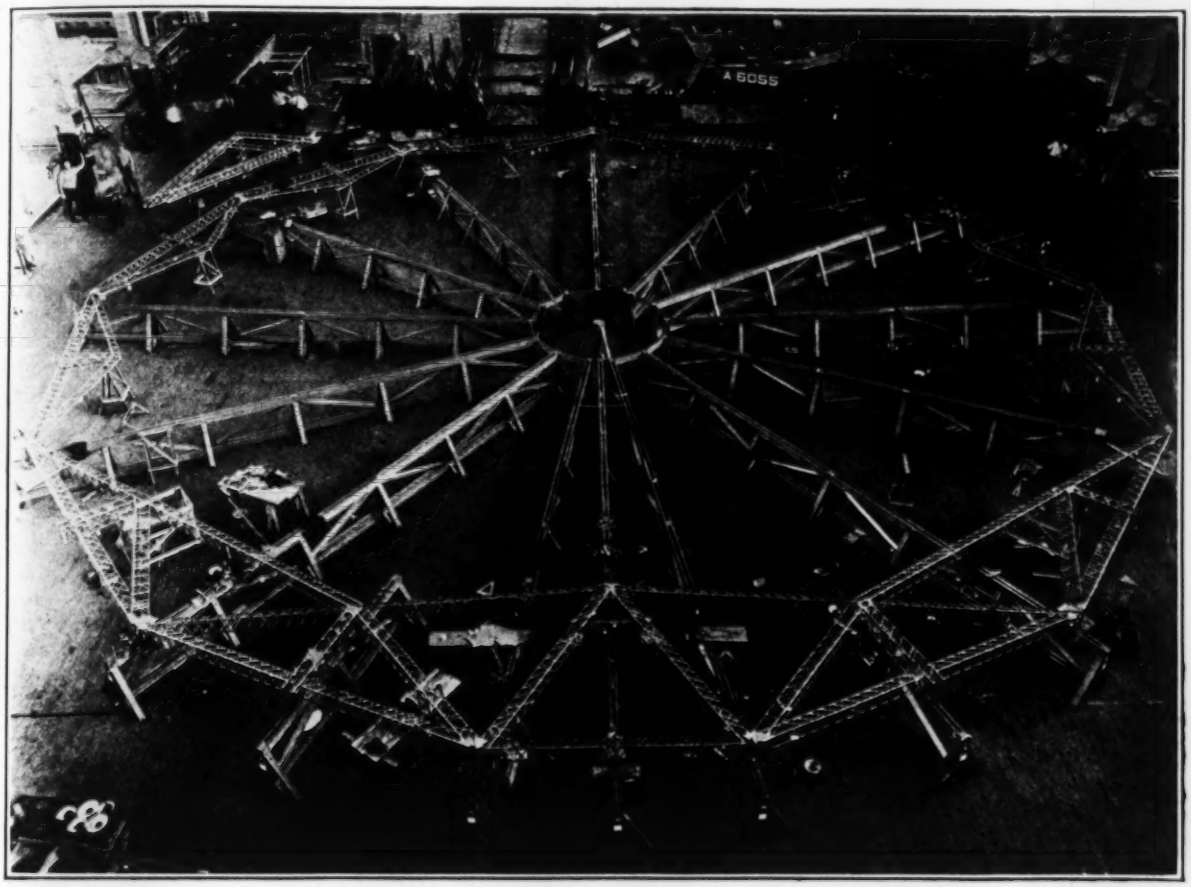


FIG. 5—MAIN FRAME ASSEMBLED AT NAVAL AIRCRAFT FACTORY DURING CONSTRUCTION

construction at Lakehurst, a complete review of the design was made by a board appointed by the Navy Department, composed of men not connected with the design of the vessel and headed by Henry Goldmark, consulting engineer, of New York City. The report of this board has not been published, but it is known to have contained a full endorsement of the design.

Stress Measurements on Finished Vessel—In addition to elaborate tests of materials and individual members, an extensive series of stress measurements also was made upon the frame of the ship when completed, both in its shed at Lakehurst and in flight. These measurements, intended to furnish a check on the stress analysis, covered a large variety of conditions. It was during their progress that the *Shenandoah*, a few months after its completion, was torn loose from its outdoor mooring mast at Lakehurst by a violent wind, and had a thrilling flight of a hundred miles or more before working its way back to its station. The accident bent and tore out the mooring spindle at the nose of the vessel and damaged the nose section extensively.

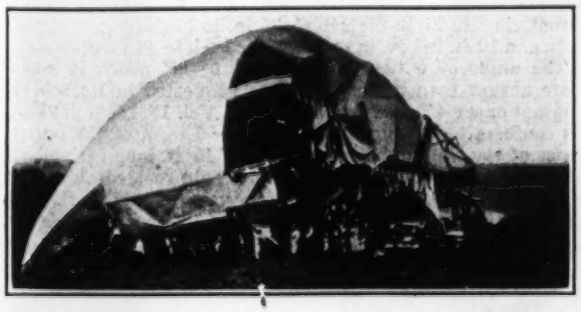


FIG. 6—WRECKED BOW OF "SHENANDOAH"

No statement of the results of the stress measurements or other conclusions as to the structural strength of the ship has been published, but it may be presumed from the complete and apparently increasing confidence of the Navy Department in the vessel that the measurements showed the stress conditions to be satisfactory and in accordance with the assumptions of the designers. In fact, subsequent to this accident the *Shenandoah* made a transcontinental flight, circumnavigating the entire United States, and still later was talked of in connection with a polar expedition.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Cold Reinforcement in Cold-Weather Concreting

Sir—Some recent editorials on the dangers and necessities in cold weather concreting recall an experience of the writer which may account for some of the failures which have been recorded.

The point in question arose on some reinforced-concrete work in which, on account of the extent and peculiar layout, it was not found feasible to enclose to permit continuous placing of concrete in cold weather. Therefore the work was carried on intermittently only when weather conditions were favorable.

Aggregates and water were heated and in addition the forms and reinforcing in place were cleaned and heated with live steam previous to placing concrete.

But on numerous occasions after several days of low temperature placing of concrete had to be postponed. For even after turning live steam into the forms for as long as thirty minutes the condensed steam froze and coated the reinforcing, that had been exposed to the low temperature of the previous days, with a film of ice.

This film of ice would have prevented any bond between reinforcing and concrete unless the heat of the concrete was sufficient to raise and maintain the temperature of the reinforcing above freezing.

New York City, Aug. 19, 1925.

G. GIFFORD SYMES,
Care H. V. B. MAGONIGLE, Architect.

Cost of Operating Motor Cars

Sir—In your issue of May 21, 1925, p. 866, there was an interesting discussion of the cost of operating a Ford car and it occurred to me that the following figures might also be of interest.

Both of the cars covered by the data were driven by the same person all the time, were greased every five hundred miles, had engine oil changed regularly, and were otherwise properly cared for. Probably two-thirds of the total mileage of both cars was upon city pavements, while perhaps a thousand miles, in each case, was over extremely bad roads, the balance being good gravel roads.

The Dodge car was bought second-hand and had been used about three years (1919 model). The car had belonged to a country doctor and probably had run up a considerable mileage. This was not recorded, however, as the speedometer had a 10,000 mile limit. The purchase price (second-hand) was $730.55 and the sale price at the end of two years was $375.00 net, after deducting a commission. The period covered was from July, 1921, to June, 1923.

The Buick was a new 1923 model, 4-cylinder car, costing $1,000 and the period covered was June, 1923 to June, 1925.

The item of tires in the case of the Dodge covers actual money paid out, but in the case of the Buick it is money paid out plus $100 estimated value of the original tire equipment, minus estimated value of $50 of the tire equipment at the end of the two-year period. Probably the difference in the costs was due largely to a difference in temperature, the Dodge being used in Alabama, while about half of the Buick mileage was in Michigan.

Depreciation on the Dodge is actual difference between purchase price and sale price while depreciation on the Buick is estimated upon the basis of a life of six years and a cost of $900, exclusive of tires.

All these figures should be considered as an indication of the difference in operating costs of a new car and an old one of practically the same list price, and not as a comparison of costs of the two different makes.

R. L. MORRISON,
Associate Professor of Highway Engineering.

Ann Arbor, Mich.,
July 17, 1925.

COST OF OPERATING TWO TOURING CARS

	Used Dodge		New Buick	
Direct Operating Cost	Total Cost	Cents per Mile	Total Cost	Cents per Mile
Gasoline	$261.54	1.80	$133.96	1.08
Oil	81.40	.56	17.35	.14
Greasing	18.10	.12	21.65	.17
Tires	204.58	1.41	115.69	.94
Alcohol (1 winter)			2.50	.02
Battery	56.88	.38	20.25	.16
Carbon and brake linings			21.00	.17
Other repairs	233.57	1.60	44.84	.38
Total	856.07	5.87	377.24	3.06
Overhead Costs				
Garage	122.00	.84	119.80	.98
Insurance and taxes	144.33	.99	176.01	1.42
Total	266.33	1.83	265.81	2.40
Depreciation and Interest				
Depreciation	355.55	2.44	300.00	2.43
Interest at 6 per cent	63.57	.44	90.00	.73
Total	419.12	2.88	390.00	3.16
Summary				
Direct operating costs	856.07	5.87	377.24	3.06
Overhead costs	266.33	1.83	295.81	2.40
Depreciation and interest	419.12	2.88	390.00	3.16
Total	1,541.52	10.58	1,063.05	8.62
Gas consumption	Total Gals.	Miles per Gal.	Total Gals.	Miles per Gal.
	1,166	12.50	626	19.75
Average cost per gal	22.5c.		21.4c.	
Total mileage in two years	14,573 miles		12,356 miles	

More Data on Tulsa Pipe Line Venturi Meter

Sir—I have been asked for additional data regarding the Venturi meter on the Tulsa pipe line. I would also like to correct an error in the computations for loss of head through this meter, as contained in my article which appeared in your issue for May 28, p. 894. The following data are assembled on a slightly different basis which I believe will be more easily visualized:

	Ft.	Ft.
Average piezometer column elevation at gage 1, Venturi intake =	677.961	
Velocity in 48-in. intake 3.52 ft. per sec.		
Velocity head for $V = 3.52$ ft.	0.193	
Elevation of energy gradient at Venturi intake =		678.154
Average piezometer column at gage 2 on 60-in. pipe =	676.960	
Velocity in 60-in. concrete pipe = 2.25 ft. per sec.		
Velocity head for $V = 2.25$	0.079	
Elevation of energy gradient at gage 2 on 60-in. concrete line =		677.039
Gross loss between Venturi intake and gage 2		1.115
In addition to net loss through meter we have the following insignficant losses:		
Friction loss in 24 ft. of 48-in. cast-iron pipe at velocity of 3.52 ft. per sec. using Hazen-Williams coefficient of 130 for new cast-iron pipe	0.018	
Loss at enlargement from 48 to 60-in. pipe	0.027	
Friction loss in 696 ft. of 60-in. concrete pipe (by test)	0.131	
		0.176
Net loss through Venturi meter		0.939
Loss through Venturi meter as tabulated in Hazen-Williams "Hydraulic Tables," p. 61, about		0.80
Loss through Venturi Meter as interpolated on curves in Herschel's "1915 Experiments" facing p. 43, about		0.85

This loss of 0.939 ft. appears excessive until the fact is considered that the throat velocity is 20.2 ft. per sec. for which the velocity head is 6.407 ft. The difference in velocity heads between throat and outlet is 6.407 — .193 = 6.214 ft. The net loss through the meter of 0.939 ft. indicates a recovery of velocity head of 5.275 ft. or 85 per cent of 6.214 feet.

This particular meter is 20 ft. 2½ in. over all in length, of which 12 in. extends from the inlet to the large piezometer ring; 8 ft. 1⅝ in. from this ring 48 in. in diameter to the throat ring 20 in. in diameter; 3½ in. to beginning of outlet flare and 10 ft. 9⅛ in. in outlet taper back to 48 in. diameter.

The angle of outlet taper is thus 6° 09′ which is much more abrupt than the angle of 2½° suggested in Herschel's original paper (*Trans.* Am. Soc. C. E., Vol. 17, 1887, p. 233). To conform to his suggested angle the length of the outlet taper of the Tulsa meter should be 27.15 ft. long instead of less than 11 ft. Such a long meter would cost considerably more. The economics rests on the value of the head lost through the meter; in this case being 1.15 per cent of the total available fall.

FRED C. SCOBEY,
Irrigation Engineer, U. S. Department of Agriculture.

Berkeley, Calif.,
Aug. 11.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Water Meter Ordinance for City of Chicago

Universal Metering in Ten Annual Installments—Standard Meter To Be Used

In addition to the provision for the universal metering of water service in Chicago in ten annual installments, as noted in these columns last week, a net increase in water meter rates was put into effect and service charges are to be made for private fire protection. Present frontage rates are not disturbed. The step-rate proposal by Dabney H. Maury, as noted in *Engineering News-Record* June 18, 1925, p. 1033, was thrown out and the present 62½c. per 1,000 cu.ft. meter rate subject to 25 per cent discount is now made 60c. subject to 15 per cent discount, making a net increase from 46.9c. to 51c. This is not sufficient to enable the city to carry out a filtration program. However, since the existing system is already adequate to care for a city twice the present size, no new pumping stations or tunnels and few feeder main extensions will be necessary for the next 25 years. To care for filtration a 40 per cent increase is necessary.

The minimum rate is to be equivalent to the frontage rate less 15 per cent. This city pays for and installs meters. It also under the new ordinance furnishes meter vaults if required.

STANDARD WATER METERS

John Ericson, city engineer, who has been strenuously advocating meters for more than 25 years, is jubilant over the passage of the ordinance. He is now busy on a standard meter which is to utilize in the design the best features of all the meters on the market. A preliminary sketch has been sent to manufacturers for criticism. Since the ordinance requires all meter contracts to be passed on by City Council awards will be simplified if all bid on the same meter. A suggestion has been made that this is a good time for the meter manufacturers to consider pooling their patents in the same way the automobile interests have done.

No plan has yet been worked out as to procedure but presumably the Sixty-Eighth St. District which gets the worst polluted water will be the first area metered so that filters may be built there first. Not much can be done until the new budget in January is made up, though some transfer of funds can be made.

The final day before the ordinance was passed was strenuous for Mayor Dever and E. J. Kelly, chief engineer, of the Sanitary District of Chicago. Political pressure from the national democratic leader, George H. Brennan, was utilized to the limit on the aldermen until a safe majority was secured. Thus at the end neither scientific nor financial considerations had any weight but without the scientific background probably Mr. Brennan's assistance could not have been enlisted.

Engineering Fifty Years Ago

From *Engineering News*, September, 1875

Engineering Journalism

THE periodical literature of engineering enjoys an advantage not possessed by that of medicine, or of law. Few besides those already in the medical profession, or those who are preparing for it, care to read reports of hospital cases, or essays upon curative science. Few who are not in the law, or reading for admission, care to dive into equity reports, or to analyse judicial decisions. Professions which have to deal respectively with human suffering and human wrong, lack attractiveness, however the labors of their professors may be valued and honored. But engineering, even to the gaze of laymen, opens up a world of magic, and its achievements surpass the fiction of mythology and the storied marvels of enchantment. To reclaim a province from the sea, to float a navy in an artificial harbor, where before were only shallows and sands, to hew a channel and to bring a river of pure water through a mountain and through miles of rocky wastes for the supply of a great city, all are works which inspire wonder and admiration in the minds of men, from the highest to the lowest.

D. T. & I. Railroad Main Line Electrification

Recent press reports to the effect that the electrification of the main line of the Detroit, Toledo & Ironton R.R. by the Ford interests will be undertaken immediately were in error. The portion which is to be electrified at the present time is about 12 miles at the north end, being the Detroit & Ironton division from Fordson to the Flat Rock yards. Locomotives for this work were ordered about a year ago as noted in our issue of Sept. 13, 1924, p. 788, when a brief description of these locomotives and ones for the New York, New Haven & Hartford R.R., which are of a similar type, was given. Both types of locomotives are in effect traveling substations, converting the alternating current of the trolley to direct current for the motors. The locomotives for the Ford road, however, use a trolley voltage practically double that now in use on similar lines.

Pneumatic Handling Devices Patents Upheld

Concrete Handling Patents Granted to John H. McMichael Held To Be Infringed

An infringement suit brought by the Concrete Mixing & Conveying Co. against the Ulen Contracting Co. and Shandaken Tunnel Corporation in the U. S. District Court, Southern District of New York, has been decided in favor of the complainant. Judge A. N. Hand Aug. 4 handed down an opinion which sustains all of the nine claims (2, 4, 6, 17, 21, 22, 28, 34 and 35) of patent 1,127,680 granted John H. McMichael Feb. 9, 1925, which were the subject of the suit.

Referring to prior attempts to convey sand by steam and compressed air as in the Goldie Patent 707,840, Farnham Patent 747,396 and Sticker Patent 758,-118 Judge Hand states as follows:

"None of these patents, in my opinion, would teach anyone with imagination and talents short of a real inventive faculty to install a conveyor which would obviate the delay and expense of laying concrete by hand about the forms on which a tunnel is built. They were kinetic devices for floating light materials. This was in substance so even in the case of the Goldie patent where dry cement, or cement mixed with sand or gravel, was ejected from a short hose by an air or steam water blast. It is not accomplished by a heavy air pressure as in the patent in suit, but by air or steam velocity.

"The application by the inventor of the necessity of limiting the concrete to be conveyed to sections of moderate size and weight and his method by the second air jet of securing the cutting off of a segment from the mass of concrete and a propulsion of this segment through the discharge pipe involves invention of a high order. His device has displaced all other methods for rapidly and economically conveying, lifting and placing concrete at long distances from the initial source of supply and has been used in numerous great enterprises. In such circumstances his claims should be read broadly and given a fair range of equivalents. When so read I think the defendants plainly infringe."

Montreal Bridge Financed

The expense in connection with the building and operation of the Montreal-South Shore bridge, now being built at Montreal, P. Q., is to be done through co-operation of the Province of Quebec, the city of Montreal, and the Montreal Harbor Commission, each body bearing one-third of the total interest charges, sinking fund, and cost of maintenance less the revenue. The provincial government has agreed to this arrangement for a period of seven years.

World Power Conference To Be a Permanent Organization

In submitting to the various countries a draft of a constitution for the permanent organization of the World Power Conference, the committee in charge has pointed out that the central office is to be nothing more than a clearing house for the interchange of information on all matters relating to the development of power resources. The conference is to be composed of the existing national committees, together with such other national committees as may be formed hereafter. Where no national committee exists the government or some representative institution may appoint a representative for the country.

The constitution will place no restriction on the type of national committee each country may choose to select, but it is recommended that each member have some first hand knowledge of scientific, technical, or industrial power problems. The management of the affairs of the conference are to be vested solely in the national committees. Much emphasis is placed on the determination to have no central super organization. The International Executive Committee is to consist of one representative from each national committee.

It is proposed further that the chairman of the council be allowed to appoint the necessary staff for carrying forward the work of the conference. The Council will determine the location of the central office, which is to remain in London until otherwise decided. The Council will determine the basis upon which member companies will contribute to the support of the central office.

The International Executive Committee which is to choose its own chairman, at the London meeting selected D. N. Dunlop. Mr. Dunlop was the organizer of the first power conference.

City Home Rule in New York State Upheld on Appeal

By a unanimous decision of the New York State Court of Appeals on Sept. 2, the municipal home rule amendment to the state constitution was declared valid, thus reversing the unanimous decision of the Appellate Division of the State Supreme Court rendered July 6 and supporting the earlier decision of the trial court. (See *Engineering News-Record*, July 9, p. 77). The opinion in the final decision will be delivered later, together with a decision on the legality of municipal ownership and operation of bus lines by New York City. The points at issue in the home rule case related entirely to a minor technical question of legislative procedure in passing the resolution submitting the amendment to popular vote. About forty cities had taken action under the amendment, some of which materially affected their charters. Thus, Buffalo had amended its charter so only three instead of four of its five city commissioners were required to authorize a contract for a garbage incinerator.

Engineer License Tested in Pennsylvania

The constitutionality of the engineer license law in the State of Pennsylvania is to be tested through a suit started by the voluntary arrest of a consulting engineer in Monroe County for failing to appear before the state board of registration. Recently Judge Maxey declared the statute null and void in Lackawanna County and has enjoined the State Board of Registration of Professional Engineers and Land Surveyors from functioning within the limits of the local court. Subsequently, Attorney General Woodruff filed exceptions to the decree of Judge Maxey in order to bring the test case before the Appellate Court.

Bids for First Activated Sludge Plant in Minnesota

Bids were received on Sept. 4 for what promises to be the first activated-sludge plant in Minnesota. It will have a capacity of 2.5 m.g.d. The plant will include a fine screen of the drum type and Dorr clarifiers, which will provide all the treatment required for more than half the year, owing to sufficient volume of the Zumbro River, which will receive the effluent. There will be a separate sludge digestion tank of rather large size, into which there will be pumped the sludge from the Dorr clarifiers and also the excess activated sludge when the aeration plant is in operation. The sludge formed in the digestion tank will be dried on sludge beds of usual design. Frederic Bass, Minneapolis, Minn., is plant engineer.

Slip in New Work on Rock Fill Dam Kills Three

An addition of 47 ft. is now being made to the height of Lake Fordyce dam, a rock-fill structure in northern California, owned by the Pacific Gas and Electric Co. The original structure was built some fifty year ago and prior to the work now under way it had a maximum height of 90 ft. and a crest length of 800 ft. Its upstream slope is 1 to 1 and has a concrete facing.

The addition to the height consists of a derrick-placed rock wall along the upstream face of the old structure, backed by a loose rock fill with a downstream slope of 1.3:1. This rock wall is 25 ft. wide at the bottom (on the crest of the old structure) and 10 ft. wide at the top. The upstream slope is ¼ to 1, and the downstream face is almost vertical, the plan being to lay this rock wall up carefully as a facing for the loose rock fill to be placed behind it later. The upstream side of the rock wall is to be concrete faced.

On Aug. 28 a break occurred in which about 1,000 cu. yd. of the downstream face of the rock wall slid down, killing three workmen and injuring three others. At the time of the accident, several hundred feet of derrick-placed rock had been finished to the full height at the north end of the dam. The slide involved a 20-ft. length of this full-height section and 40 ft. of adjoining wall not yet built to full height.

Progress in the Installation of Automatic Train Control

The work of installing automatic train control devices on 7,745 miles of 45 of the Class I railroads of the United States, as ordered by the Interstate Commerce Commission, has reached the point where, on Aug. 1, the installation of such devices either has been completed or is under way on a total of 5,044 miles. On Jan. 1 of this year the corresponding mileage was 3,792. Thirteen railroads have actually completed permanent installations, 16 railroads have permanent installations now under construction, preliminary installations have been completed by 13 railroads, and 3 others have preliminary installations now under construction.

The types of train control devices selected are as follows: Three railroads have chosen the ramp type, 23 the intermittent induction type, 13 the continuous induction type, and 6 the plain automatic stop using continuous control.

The original automatic train control order was issued in June, 1922, and required that the installation on 49 railroads be completed by Jan. 1, 1925. As now modified, it applies to 45 railroads. A subsequent order, issued in January, 1924, ordered 47 of the roads listed in the original order to install control devices on a second division, but later five of these roads were exempted. The same order covered the installation of train control devices on 45 additional roads, but this part of the order has been suspended. This order requires the installation to be completed by Feb. 1, 1926.

Engineering Council Will Aid City of Denver

The Colorado Engineering Council, comprising the Colorado sections of the national engineering societies and of local societies, has agreed to aid Denver in an advisory manner, without cost to the city. The feasibility of any proposed work by the city will be given due consideration and its practicality passed on, free of cost, but any drawing of plans and specifications is to come under the regular order of work to be paid for. The Colorado Engineering Council was organized in 1919.

Colorado River Compact Endorsed By Three States

At the meeting of the representatives of the upper Colorado River basin states, held in Denver, Aug. 29, a declaration was prepared to the effect that the States of Utah, Wyoming and Colorado were in favor of adhering to the Colorado River compact as now drawn up. These states were represented by their governors, state engineers, and water commissioners. The meeting was for a purpose similar to the one held in Phoenix, Ariz., on Aug. 17, which was brought to an abrupt end by the ultimatum of Governor Hunt of Arizona, as noted in last week's issue.

WASHINGTON NOTES

More water must be made available to keep the West out of a welter of litigation which may retard its development for a quarter of a century. Water rights are so indescribably complex that the only escape from conflict is the providing of water enough for all. This can be done if money is spent on cement and not on lawsuits.

These are some of the conclusions of Commerce Secretary Hoover based on his intensive first-hand observations while on his recent western trip. He finds that from seven to fifteen agencies have a hand in each project involving the use of water. These activities must be coordinated, he declares, so that more money will be available for reservoirs.

Despite the fact that the Monongahela long has enjoyed the distinction of being the world's busiest waterway, the density of traffic on this stream is increasing at such a rate that it is hard for improvements to keep pace with the demands of commerce. Gen. Edgar Jadwin, the acting chief of engineers, recently returned from a trip over the river during which he inspected some of the engineering works on the stream. The availability of the 56 x 720-ft. Elizabeth locks, which will accommodate at one time a tow boat and six barges, the standard fleet on the Monongahela, is proving a great asset to those using the river.

Gen. Jadwin is impressed with the additional tonnage which must be handled by water because of the improvement at the Alice coal mine of the Steel Corporation. That property now has in operation a belt conveyor having a capacity of 10,000 tons daily. The other steel companies also are augmenting their output of water-borne coal.

Gen. Jadwin points out that the intensive use of waterways in the Pittsburgh area is not confined to the Monongahela. The tonnage on the Allegheny has doubled in ten years and now exceeds 5,000,000 tons. The practical completion of the system of dams, with 110x600-ft. locks, on the Cincinnati-Pittsburgh sector of the Ohio means, Gen. Jadwin believes, the extension of the zone of dense traffic to include that 470-mile stretch of improved waterway. While the traffic on the Ohio will be of a different character from that in the Pittsburgh area, it promises to grow rapidly into a very large tonnage.

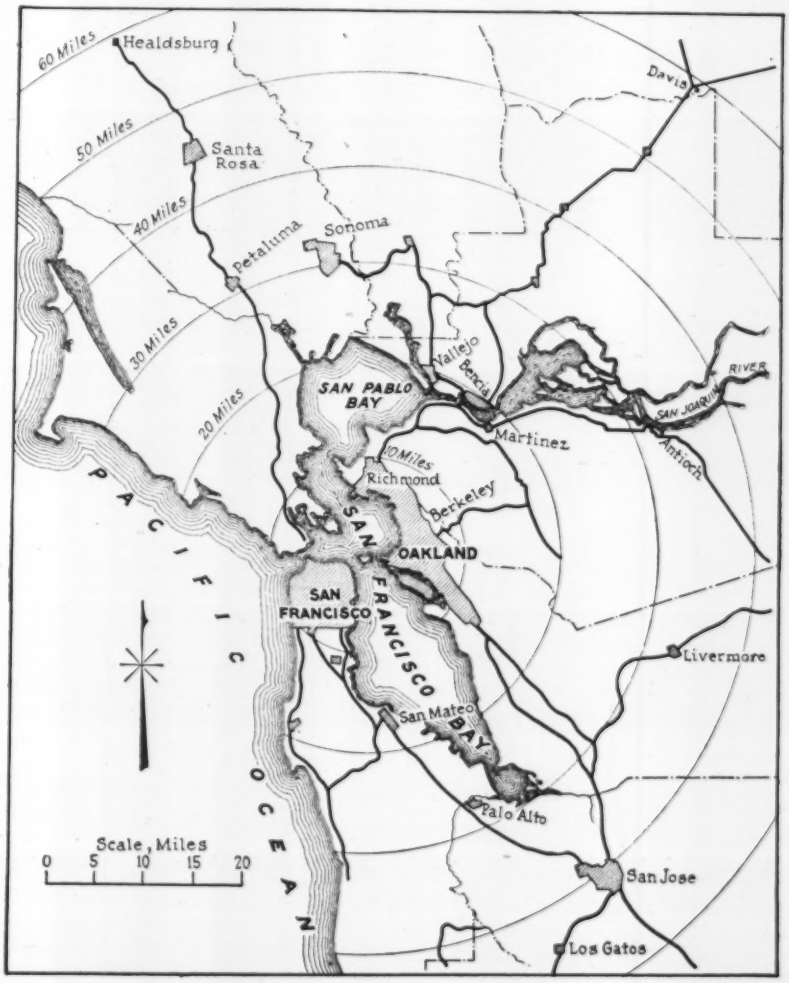
The Niagara Control Board last week inspected the New York barge canal between Lockport and Genesee. This periodic inspection is to satisfy the board that no water is being withdrawn for power purposes in excess of the amounts agreed upon in the treaty of 1909. The Board made a careful inspection of the diversion of 500 sec.-ft. through Eighteen Mile Creek at Lockport for power development which recently was authorized by the Federal Power Commission.

Plan Regional Development of San Francisco Bay Counties

An exhaustive survey of physical, economic, industrial, social and living conditions in the greater part of nine California counties adjacent to San Francisco Bay is to be made in order to determine the needs of the district so that plans may be formed for its future development. The survey will be made by Harland Bartholomew, city and regional planning engineer, St. Louis, Mo., who has been engaged for that purpose by the Regional Plan Association of the San Francisco Bay Counties. Mr. Bartholomew recently arrived in San Francisco to commence the work.

The territory under consideration extends, roughly speaking, 60 miles north, 50 miles south and 30 miles east of San Francisco, covering an area of approximately 4,000 sq. mi. and including a total population of about 1,500,000. There are 59 incorporated municipalities in this area, including Healdsburg on the north, Antioch on the east, and Los Gatos on the south.

The Regional Plan Association, "organized to formulate and promote a comprehensive plan of development of the bay counties", is the result of research work done by the City Planning Section of the Commonwealth Club of San Francisco. The club having been organized purely for research purposes, a number of public-spirited citizens were asked to carry on the development work and a committee of prominent business men has been named for that purpose. The committee includes one engineer, C. J. Rhodin, who was made executive secretary with headquarters at 519 California St., San Francisco.



AREA TO BE INCLUDED IN REGIONAL DEVELOPMENT PLAN

Tests of Highway Paving Material

The county commissioners at South Bend, Ind., have begun an experiment to test the relative values of different materials for road pavement. The first section of 500 feet of asphaltic concrete pavement on the Lincoln highway west of the city has been awarded. Contracts calling for six different kinds of materials to be used in resurfacing six successive 500-ft. sections of the highway will be awarded. It is the purpose to determine the comparative wearing qualities of all the well known materials.

Civil Service Examinations

UNITED STATES

For the following civil service examinations apply to the U. S. Civil Service Commission, Washington, D. C., or to any local office of the commission.

Junior Technologist — Vacancies in the Bureau of Standards, Department of Commerce, Washington, D. C., at an entrance salary of $1,860 a year. After the probational period of six months advancement in pay may be made to $2,400 a year. Competitors will be rated on general chemistry and elementary physics; mathematics up to and including calculus; practical questions on each optional subject chosen; and education, training, and experience.

Receipt of applications will close Oct. 10, 1925.

Junior Metallurgist — Vacancy at Frankford Arsenal, Philadelphia, Pa., and vacancies in positions requiring similar qualifications. The entrance salary is $1,860 a year. Advancement in pay may be made up to $2,400 a year. The duties consist of general metallurgical work and research work on a large variety of metallurgical problems. Competitors will be rated on general chemistry, elementary physics, metallurgy, and education, training, and experience.

Receipt of applications will close Sept. 26, 1925.

Engineering Societies

Calendar

Annual Meetings

NEW ENGLAND WATER-WORKS ASSOCIATION, Boston, Mass.; Annual Convention in connection with trip on St. Lawrence River, Sept. 8-11, 1925.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Fall Meeting, Montreal, Que., Canada, Oct. 14-16, 1925.

AMERICAN PUBLIC HEALTH ASSOCIATION, New York City; Annual Convention, St. Louis, Mo., Oct. 19-22, 1925.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, Lakeland, Fla.; Annual Meeting, Des Moines, Iowa, Oct. 26-30, 1925.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, Washington, D. C.; Annual Convention, Detroit, Mich., Nov. 18-20, 1925.

The American Public Health Association will hold its 54th annual meeting in St. Louis, Mo., Oct. 19-22. With a view to correlating the various public health services, both official and non-official, the program will include a greater number of joint sessions than general sessions as has been customary in the past. The association's nine sections, including those of public health administration, laboratory, and sanitary engineering, will also have programs of their own consisting of one or more sessions. One of the subjects to be discussed from various angles is that of oyster pollution.

The executive secretary of the association is Homer N. Calver, 370 Seventh Ave., New York City.

Personal Notes

HORACE C. KNERR, chief metallurgist, U. S. Naval Aircraft Factory, has resigned to engage in professional practice as consulting metallurgical engineer at Philadelphia, Pa.

J. H. DOWLING, highway project engineer at Madison, Fla., has been appointed division engineer of the second division of the Florida Highway Department, with headquarters at Lake City, Fla.

DR. ERNEST C. LEVY, who recently accepted the chair of preventive medicine at the Medical College of Virginia, as noted in these columns Aug. 20, has been appointed head of the health department of the city of Tampa, Fla., and has been granted an indefinite leave of absence from the Virginia college.

GEORGE LEWIS, general manager since January, 1925, for the construction of the Moffat tunnel, has been appointed chief engineer, relieving R. H. Keays, whose resignation was noted in our issue of Aug. 20, 1925, p. 319.

THE KELLY-ATKINSON CONSTRUCTION CO., engineers and contractors, Chicago, announce the formation of two subsidiary corporations, the Kelly-Atkinson Building Co., with E. A. Wall, vice-president, and the Kelly-Atkinson Foundation Co., with J. F. Wilhelm, vice-president.

S. M. GOODWIN, formerly an assistant secretary of the Interior, has resigned to become the representative in Washington of the Columbia Basin Irrigation League.

S. A. WALLACE, engineer in the office of the district engineer, United States Bureau of Public Roads, Denver, Colo., has been appointed resident engineer at Jackson Hole, Wyo.

SCOTT MITCHELL, for the past five years city manager of Boulder, Colo., has resigned, effective Nov. 1, in order to return to the contracting business. No successor has been named yet.

WILLIAM C. WETHERILL, of the department of mechanical engineering, University of Pennsylvania, has joined the staff of the Department of Commerce to act as director of investigations into the utilization of metals, the introduction of simplified practice and the elimination of waste in metal-using industries.

MAJOR WALLACE W. KIRBY, who has been in charge of the engineer reproduction plant at Washington Barracks, has resigned his commission in the army to enter private practice. Major Kirby's commission was in the Corps of Engineers. During the war he was in charge of map reproduction work in the American Expeditionary Forces in France. More recently he acted as director of the Bureau of Engraving & Printing following the upheaval which occurred in that department, the last six months of which service was authorized by a special act of Congress made necessary by a ruling of the Controller General that an army officer could not serve in a civilian capacity for more than a year without such authorization.

C. E. DRAYER, secretary of the American Association of Engineers for seven years until last spring, has joined Crosby-Chicago, an advertising agency, as general manager and treasurer. He becomes also a director of the corporation in the reorganization, due to the death of its founder and president, John Bemer Crosby.

J. W. FOX, right-of-way engineer, Florida East Coast Railway Co., has been appointed assistant to vice-president, in charge of real estate and valuation, with headquarters at Saint Augustine, Florida.

ERNEST K. SORENSEN, formerly secretary and treasurer of The New York Continental Jewell Filtration Co., and for eight years (1910-1917) secretary of the Water Works Manufacturers Association, has recently become associated with James E. Williamson, designers and builders of water purification plants, at 39 Cortlandt Street, New York. Mr. Williamson has for the past thirty years been identified with the design and construction of filtration plants.

LAMAR LYNDON, consulting engineer, New York City, has returned to his office after an absence of more than two years in France, Mexico and California, with health completely restored.

R. V. ORBISON, city manager, South Pasadena, Calif., has been appointed city manager of Pasadena, Calif., succeeding C. W. Koiner who resigned July 1. Mr. Orbison had been city manager of South Pasadena since 1920, before which date he was city engineer of Pasadena, having first served as assistant city engineer there.

Obituary

JOB ROCKFIELD FURMAN, late superintendent of erection on the Chicago Union Station, died at Chicago Sept. 7, age 60 years. Mr. Furman was a native of Westchester, N. Y., and a graduate from Stevens Institute of Technology in the class of 1885. Soon after graduation entered the employ of the firm of Otis Bros. & Co., going to Europe as their representative, where he was in charge of the elevator installation in the Eiffel Tower. Later he returned to this country to continue work in the design of elevators, returning to Europe twice for special elevator construction.

From the Manufacturer's Point of View

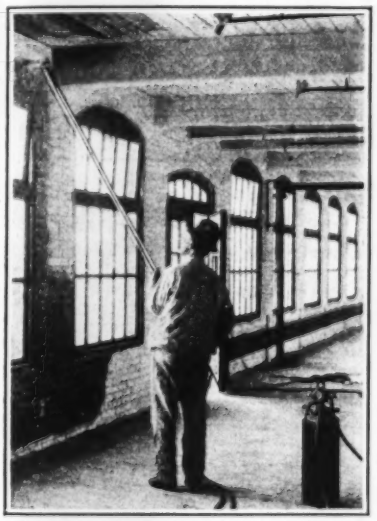
A Point of Contact Between Maker and User of Construction Equipment and Materials

Spray Painting Helps Engineers to Reduce Costs

By Ray W. Tripp
Spray Engineering Co., Boston, Mass.

TODAY in modern painting practice, by making use of the principle utilized in an ordinary atomizer, there is available a type of apparatus that will enable any ordinary workman to accomplish several times as much work in a day as can be done with a brush. This apparatus forms the basis of the spray method of applying paint or other liquid coatings.

Compressed air supplied from a portable gasoline engine or motor-driven compressor, or from an outlet in a main building with a compressed-air



EXTENSION POLE SPEEDS UP WORK

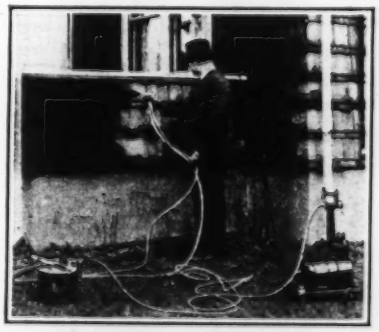
system supplies the power. The material to be sprayed is placed in a steel tank, put under pressure and forced through a hose which leads to the spray gun. Compressed air is also brought to the orifice of the gun through a second hose. The painter has both air and material under absolute control, can regulate them at will, and apply exactly the needed quantity to the surface to be covered.

There are two distinct types of equipment—portable and stationary. The stationary type is used in connection with painting furniture, automobiles, and other miscellaneous manufactured commodities. The portable equipment is of particular interest to the engineer or contractor as it supplies a speedy, easy and economical method of painting all large stationary objects including buildings, tanks, bridges, standpipes, and structural steel work of all sorts; it is also used for marking highways with traffic guide lines and for other similar work. Some of the illustrations accompanying this article show the use of paint spraying apparatus, including the use of an extension pole which reduces the cost of staging and scaffolding to a minimum.

Cost Data—Some comparative costs of painting with a brush and the spray method are of interest. In general, the painting contractors estimate from 50 to 75 per cent of any painting job for the labor cost. A manufacturer of industrial paints, in advertising his particular brand of mill white, quotes 3 hr. and 10 min. as the least time required to spread 1 gal. of paint with a brush in the hands of an experienced workman. A mill interior at River Point, R. I., was painted at the rate of 30 gal. per day per man or 16 min. to spread 1 gal. At the wage rate obtaining at the time, 80c. per hour, the old brush method cost $2.53 a gallon to apply; the spray method cost 21c. a gallon.

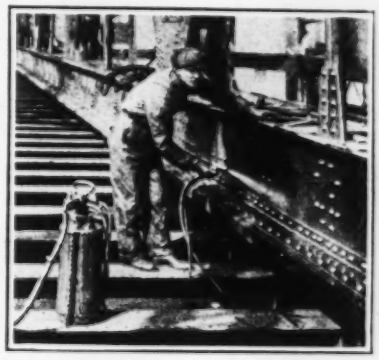
Another comparison, derived from actual work, showed that to paint 280 sq.ft. of surface required 3 hr. 10 min. time, at $1 per hour hand-labor with a brush, and $1.80 worth of paint. To cover this same surface by air-brush painting used a little more paint (the cost of this being $2) but the job was done with the same labor in 20 min. As a matter of average experience, spray painting uses approximately the same amount of paint, but saves from 65 to 80 per cent of the labor as compared with the brush method.

Equipment—The next point to be considered is the type of equipment required for work such as the engineer has under his control. The standard equipment recommended and used on this work consists of a portable container of 5 or 10 gal. capacity, with control head for regulation of air and paint pressures, this head containing reducing valves, air and paint strainers, pet cocks, indicating gages, a paint gun of suitable design, with two guns operated from one head, if desired, an all metal extension pole, and air and material hose in lengths to meet all requirements. A portable compressor outfit, either gas engine or electric motor driven, with air storage tank, necessary gages and safety valves, will complete the outfit.



SMALL EQUIPMENT OPERATING FROM ELECTRIC LIGHT SOCKET

Realizing that there are certain little "touching up jobs" to be done almost daily, one of the manufacturers of spraying devices has made a smaller outfit for this class of work. This small outfit comprises the following: A paint gun connected by suitable lengths of hose to a material container of either 1½ or 3 gal. capacity so constructed that a quantity of paint as small as a pint can be handled satisfactorily. This feature is desirable



EQUIPMENT FOR PAINTING STRUCTURAL WORK

when color changes are frequent or small jobs are to be done. This outfit is run by a small electrically driven compressor unit, whose total weight is 112 lb. The compressor is operated by a small motor that may be connected to any ordinary lighting socket.

The selection of the right type and size of equipment and accessories is of greater importance than the average user appreciates, and it would be advisable for any one in the market for equipment of this nature to place his problem before recognized manufacturers. With their years of experience in this line they are in a position to recommend the proper equipment.

Application Data—The spray method of painting uses slightly more paint than the brush method, but none of the paint is wasted if the equipment is properly operated. A minimum coverage of 4,000 to 5,000 sq.ft. is obtained in an 8-hr. day, while as much as 10,000 sq.ft. is often painted on large free surfaces. The use of line boards or protecting glass permits a spraying apparatus to be used for painting window sash, woodwork, and all small trimming. An air pressure of 40 to 55 lb. produces the best results from spraying apparatus. By means of an adjustment of the air pressure, different paints may be applied with the same apparatus. The width of the surface covered by the spray when the gun is held 8 in. from the surface to be coated, corresponds to that covered by an 8-in. brush. It is possible to secure a round conical spray or a broad fish tail spray, and the thickness of the paint film may also be easily regulated. Cold water paints,

bronze solutions and heavy lead paints that are kept in suspension are made ready for application by an air-operated agitating attachment.

There are no doubt many millions of dollars worth of buildings that have failed to receive the customary coats of paint during the present era of high prices and labor. Much of this neglected work now demands immediate attention if the property is to be saved. New building will soon be demanding its share of protective coatings. The painting of traffic lines or safety stripes on street pavements and highways is recognized as a necessity and as a matter of growing importance to the highway engineer. By using the spray method, it is possible to decimate labor costs, speed up the work and obtain absolutely clean-cut stripes. A test made with an outfit used by the Massachusetts Highway Commission showed a speed of application of 75 ft. per minute—actual spraying time. Apparatus of this sort requires two or three men and a motor truck. Furthermore, as an added advantage the same equipment can be used for painting guard rails, bridges, buildings, etc.

The practicability of spray painting has been determined. The experimental stage has been passed and the spray painted interior, as well as the exterior surface, has proved to be as durable and lasting as the brush painted surface.

National Industrial Advertisers to Convene in October

The National Industrial Advertisers Association will hold its fourth annual convention at the Hotel Chalfonte, Atlantic City, October 19-21. President Julius Hall has appointed W. A. Wolff of the Western Electric Company, general chairman of the convention and chairman of the program committee.

Business Notes

GIBB WELDING MACHINES CO., Bay City, Mich., manufacturer of electric welding equipment, announces the appointment of Arthur Jackson as sales representative at Toronto, Ont.

MONARCH TRACTORS, INC., Watertown, Wis., announces the appointment of R. W. Gotshall as vice-president and general manager, and of H. B. Baker as vice-president and director of sales. Mr. Gotshall was formerly assistant manager of Holt Mfg. Co., Peoria, Ill., and was for 17 years connected with that firm; Mr. Baker has been sales manager of the Holt company for the past 12 years.

W. B. MARSHALL has joined the staff of the Chicago office of the Chain Belt Co., Milwaukee, Wis. Mr. Marshall has been with the Chain Belt Co. since 1921. He will specialize in engineering sales on material handling machinery.

PARADON ENGINEERING CO., Long Island City, N. Y., announces the appointment of the following men to handle the sales and service of its chlorinators: F. H. Bradford, Chicago, for the states of Illinois, Michigan, Wisconsin and Indiana; S. P. Rees, Atlanta, Ga., for the Southern States; and C. C. Behney, Pittsburgh, for the states of Ohio, Kentucky, West Virginia and western Pennsylvania.

E. E. SEYFERT, formerly district manager of sales for the Corrugated Bar Co., Inc., and later for the Kalman Steel Co., has accepted a position with the Federal Alloy Steel Corp., Philadelphia, to take charge of its sales of reinforcing bars.

AUGUST SLUSSER, works manager, Westinghouse Electric & Mfg. Co.'s foundry at Trafford City, Pa., and prominent in Trafford City affairs, died in his home at Trafford City, Aug. 3.

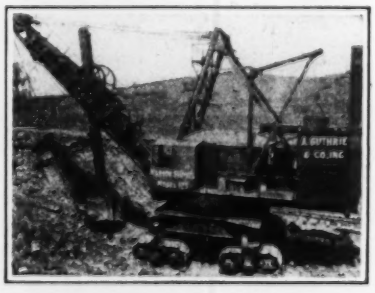
Equipment and Materials

Extra Heavy Construction on New Crawler Steam Shovel

The new full revolving shovel, Model 125 made by the Marion Steam Shovel Co., Marion, Ohio, has large dipper capacity, is mounted on crawler traction trucks, and is designed throughout for hard work and tough digging. The design and construction are such that the main upper frame which carries all the machinery, including the boiler, piping and cap, can be shipped as a unit on railroad trucks. Because of this, a minimum amount of erection is necessary in the field.

The machine is mounted by three-point suspension on four crawling traction trucks and equalizing is accomplished by means of a pivoted cast alloy steel axle. In traveling over uneven ground the front trucks with their axle are free to adjust themselves only in a vertical plane always parallel to rear axle. This relieves any tendency to create stresses or strains in the frame, or cause a steering movement. In the crawler trucks alloy cast steel frames with thirty-six inch links are used. Propelling is accomplished entirely through gears to all four of the crawler trucks

The lower frame is constructed of 30 in. I-beams. The two side beams project at the corners to accommodate the jack castings and rear crawler bearing castings. The top of the frame

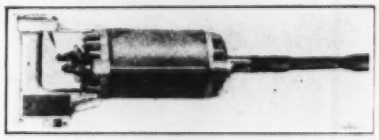


is covered with heavy one-inch gusset plates. The lower circle is made up of 80-lb. rails and is 16-ft. in diameter. There are 36 alloy steel rollers used and each is bushed and individually lubricated. The boiler is a locomotive type with a fire brick arch as standard equipment. It is so located lengthwise on the machine as to facilitate cleaning and replacing tubes without removing any piping. The hoisting engines are horizontal with single gear reduction to hoisting drum. All bearings in the hoisting machinery unit are fitted with half-brass shells and babbited caps.

The main bearings are equipped with the flooded oil lubrication system similar in design to that of an automobile engine and consisting of a motor-driven oil circulating pump sump tank, conductor and drainage piping. It is claimed that this is the first power shovel to be equipped with a pressure oiling system. It is further claimed to be the largest and heaviest excavator that has ever been mounted on crawling traction trucks. The shovel can be very easily converted into a dragline with 80 ft. boom by changing the booms and adding the drag drum. A similar shovel equipped with two motor generator sets driven by synchronous and induction motors, individual generators being supplied for the hoisting, swinging and crowding motions is also available.

Electric Hammer for Drilling and Surfacing Concrete

An electric hammer that contains no motors or gears but operates magnetically from the alternate energizing of solenoids placed around the opposite ends of the barrel is a new product of the National Electric Mfg. Co., Pittsburgh, Pa. The barrel is made of

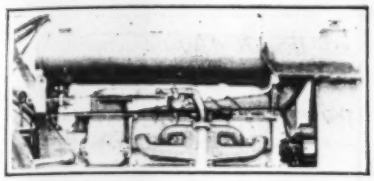


bronze and serves as a cylinder for the steel piston that is drawn back and forth by the magnetic action of the solenoids. On the down stroke the piston strikes the shank of the inserted tool and on the upstroke it strikes a recoil spring. This new hammer known as B-3 is somewhat similar to the other hammers that the company makes but contains several new features: The piston rides in replaceable bushings; all parts are clamped together—not threaded; the recoil spring is exposed at the top. The hammer weighs 29 lb., uses about 9.5 amp. of current and on 60 cycle current the piston strikes 3,600 blows per min.

An auxiliary apparatus for use with this hammer permits it to drill holes in the ceiling while the operator stands on the floor. It consists of a telescoping rod set on a coil spring that maintains the pressure of the hammer on the drill bit. The apparatus is provided with or without wheel-barrow transporting trucks.

Governor for Fordson Tractor

The new fly-ball governor for Fordson tractors manufactured by the Wehr Co., Milwaukee, is adjustable from the driver's seat permitting the operator

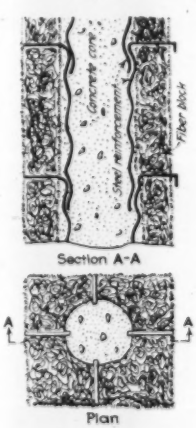


to take advantage of either hard pulls or idling requirements. The revolving parts are carried on ball bearings, that are interchangeable with Ford generator bearings; the thrust bearing is also of the ball bearing type. The governor case is oil tight and all parts run in a bath of oil.

It is claimed that the governor can be completely installed in fifteen minutes. There is no change required in the regular Fordson timer, the connection to the power plant being made through the throttle.

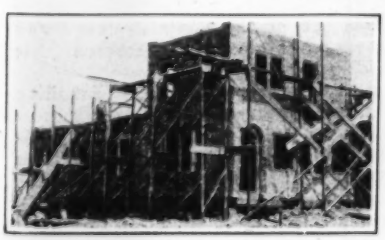
Building Blocks of Excelsior Molds and Concrete Core

Building blocks in which pressed and chemically treated excelsior is utilized as a mold for a circular core of reinforced concrete are being manufactured by Stockade Building System, Inc., New York City. They are claimed to be very economical for those structures in which the weight and strength of the ordinary heavy masonry wall is not utilized nor necessary. In addition to serving as a mold for the concrete the fibrous blocks afford protection against fire, moisture and sound and their chemical content is proof against vermin. The molds weigh 4 lb. and are equivalent to 8 bricks in volume. A 1:2:4 mix of concrete is recommended for the core and the reinforcing system is four corrugated steel strips about ¾ in. wide equally placed near the outside of the core.



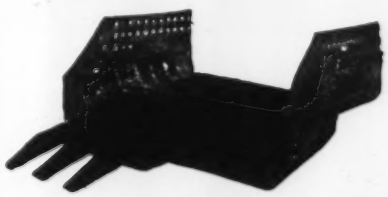
Construction is carried up three courses at a time for convenience and so that the holes in the different courses will center. Methods usually employed in bricklaying are recommended for the erection of these blocks although no mortar is used. Plaster and stucco are applied directly to the inner and outer surfaces of the molds. There are required 225 standard blocks for 100 sq.ft. of 8 in. wall. Seven bags of cement and other materials in proportion are required for each one thousand blocks.

The one illustration shows a typical wall section while the other shows a residence being constructed of Stockade blocks at Long Beach, Long Island, N. Y.



Rugged Dipper Front made of Manganese Steel

A patented dipper front known as the Clark bridge type is a new product of the American Manganese Steel Co., Chicago Heights, Ill. The bottom of the equipment has a double wall supported by connecting ribs which in turn form sockets for teeth. The ribs are so arranged that the front may be equipped with the number of teeth that



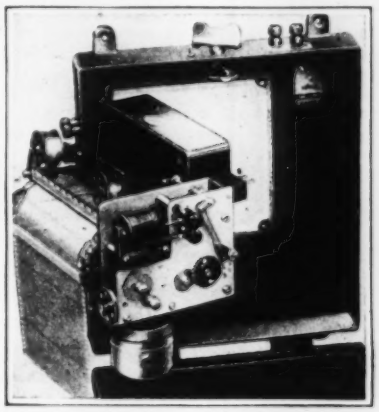
will give the most efficient digging results, the procedure in any case being to place digging teeth of square tool steel and pick-up teeth made of manganese steel in alternate tooth-pockets. A small renewable wearing band is provided on the outside of the cutting edge. The teeth may be readily changed in length by inserting small blocks. A feature of design lies in the fact that the teeth are always in the same plane, allowing an even distribution of shock and wear on all the teeth.

The name "Bridge Type" is derived from the construction of the digging edge which is formed by an integral inside and outside wall joined together by numerous braces.

Recording Pyrometer Marked for Its Simplicity

A new recording pyrometer that may be used for measuring temperature, electricity, speed and pressure has just been placed on the market by the Brown Instrument Co., Philadelphia, Pa. The instrument contains no solenoids, motors, hand winding apparatus or equipment for inking the pen. The mechanism is mounted on the door of its 15x14x9 in. aluminum case and carried on a single hinge so that when swung aside, the galvanometer is instantly accessible as shown in the illustration.

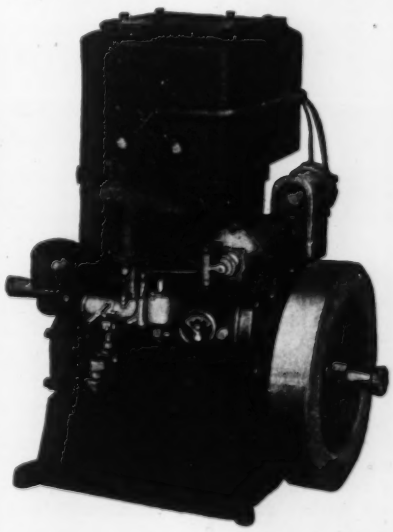
The instrument operates on the frictionless principle in which a pointer swings freely, and at intervals of every 30 sec. is depressed on an inked ribbon producing a mark on the chart. The record is visible immediately after it is made and can be torn off two hours after the last impression is recorded. The pointer is driven by an electric clock operating on alternating current. The chart speed can readily be changed



and is supplied for a number of speed combinations from ¼ in. per hr. to 6 in. per hr. With a standard chart speed of 1 in. per hr., a 12 hour section of the chart is visible through the front of the case. The switch dial shown in the illustration indicates the number of the thermocouple or furnace that is being recorded when the instrument is used as a multiple recorder. Record lines are made in different color combinations on the chart and the dial is numbered and colored to correspond.

New Two-Cylinder Engine for Industrial Use

A two-cylinder gasoline engine especially for industrial use is a new product of the Fuller & Johnson Mfg. Co., Madison, Wis., and is known as their model AB. It is rated 5 to 9 hp. at speeds of from 900 to 1,200 r.p.m. on main shaft and from 300 to 600 r.p.m. with a separate low speed back gear shaft. This back gear shaft is optional equipment, power on the standard machine being taken direct from the crank shaft. In case the low speed shaft is used gear reductions of



2 to 1, 2½ to 1, and 3 to 1 are available. Double row ball bearings carry the power end of the low speed shaft while other bearings are bronze backed and babbitt lined.

The engine is designed to operate in either direction of rotation and can be furnished with one or two flywheels. Lubrication is by a gear driven oil pump. The engine may be either radiator or tank cooled. Optional equipment includes clutch, metal housing, and impulse starter. Refinements in design are seen in placing all working parts on one side of the engine to secure accessibility. In addition, the pistons can be removed from either the bottom or top without disturbing the crank shaft.

Publications from the Construction Industry

Diesel Engines—FAIRBANKS, MORSE & Co., Chicago, have pictured the present-day engineering refinements that enter into the construction of Diesel engines and what these refinements mean to the purchaser in a new bulletin entitled "Modern Methods in Diesel Engine Building." The bulletin also contains many illustrations of the manufacturing methods used in the company's plant.

Centrifugal Pumps—BARRETT HAENTJENS & Co., Hazelton, Pa., has issued a new bulletin on the "Automatic Operation of Centrifugal Pumps." In 24 pp., the bulletin describes, by text, illustrations and drawings, various automatic control devices that not only start and stop the pump but insure it against damage due to lose of water, suction air leaks, and other operating difficulties.

Clamshell Buckets—GEORGE HAISS MFG. CO., INC., New York City., in its new catalog 425, describes its complete line of clamshell buckets for excavating and rehandling work. Data are also given on a counterweight holding drum.

Irrigation Equipment—R. HARDESTY MFG. CO., Denver, Colo., have recently published a 240 page catalog which it calls the "Irrigation Equipment Handbook." The catalog is divided into the following sections, each section treating its subject with text, illustrations, technical tables and research experiment results: Dams, flumes, gates, gate lifts, measuring devices, pipes and several small divisions covering appurtenances. A section of the handbook is devoted to specifications for irrigation equipment. Numerous hydraulic formulas and tables are given in addition to a general index and an index to the reference data.

Belt Conveyors—JEFFREY MFG. CO., Columbus, Ohio, in catalog No. 409 gives complete details and specifications for its belt conveyors of both the stationary and portable type. A list of industries and the materials that they handle with belt conveyors is given, as well as several pages of installation photos.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

This Week's Contracts—Week Ago—Same Week Last Year

THE money value of contracts reported in the present issue of *Engineering News-Record* is here compared with the gures for corresponding weeks.

Minimum costs observed are: $15,000 for water-works and excavations; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial buildings.

Money Value of Contracts Let—Entire U. S.

Week Ending	Public Work	Private Work	Total Contracts
September 10, 1925	$17,898,000	$28,553,000	$46,451,000
September 3, 1925	16,215,000	69,424,000	85,639,000
September 11, 1924	26,691,000	15,727,000	42,418,000
Heaviest Week			
1925, Sept 3	16,215,000	69,424,000	85,639,000
1924, May 8	26,370,000	38,829,000	65,199,000
January 1 to Date			
1925	749,310,000	988,602,000	1,737,912,000
1924	727,881,000	737,105,000	1,464,986,000

Rents of Small Houses and Apartments Tending Downward

Rental values appear to be definitely on the downward trend, according to reports from 179 localities throughout the United States to the Cost of Living department of the National Industrial Conference Board.

Rents of small houses and apartments, such as are occupied by families of moderate means, within the year ended last July, show an average drop of 3¾ pr cent. This decline is an average for the country as a whole, taking into account large as well as small cities in various sections, and does, therefore, not apply to any one specific locality. While the decrease is not great in itself, it represents the net result of fluctuations upward as well as downward, and is significant, according to the Conference Board, of what appears to be a growing tendency toward lower rent levels generally.

The highest rents within a decade were obtained about a year ago, in July, 1924, when average rental values for the country were 86 per cent higher than in 1914. Thereafter, rents on the average declined slowly but steadily, until last July they had dropped to a point only 79 per cent higher than the pre-war level.

Among the 12 largest cities, Boston alone reported an increase during the past few months, but too slight to affect the general level. The tendency toward lower rents, however, was indicated unmistakably in Buffalo, Chicago, Los Angeles, New York and San Francisco. No change was reported in Baltimore, Cleveland, Detroit, Philadelphia, Pittsburgh and St. Louis since last spring. Rates in Buffalo, Chicago, Detroit, Los Angeles, Philadelphia and Pittsburgh, however, still were higher by 100 per cent or more than they were before the war.

The cheapest cities to live in at present, from the tenant's view point, are Bay City, Mich., Billings, Butte and Miles City, Mont., and Sedalia, Mo., where houses of the type described may be had now at rates lower than 11 years ago. Comparatively low rents are the rule also in Bridgeport, Conn., Alliance and Springfield, Ohio, Augusta and Savannah, Ga., Charleston and Columbia, S. C., Davenport, Ia., El Paso and Fort Worth, Texas, Flint, Mich., Great Falls, Mont., Mobile, Ala., Omaha, Neb., Portsmouth and Roanoke, Va., Superior, Wis., Tacoma, Wash., Tulsa, Okla., and Wichita, Kans., where average rental values last July were not more than 30 per cent higher than the 1914 level.

Some extraordinarily high rents are reported from some of the smaller cities. Average rents in Johnstown, Pa. are still nearly 200 per cent higher, and in Kenosha, Wis., between 160 and 170 per cent higher than in 1914. Louisville, Ky., rents still average about 150 per cent more than before the war.

Foreign Projects of Interest to Americans

Further information is available on these projects at the Bureau of Foreign and Domestic Commerce or its district co-operative offices, when a reference number is given.

Drainage system extension planned in India. An important municipality in India is considering projects for further extensions of the city's drainage and sewerage systems. Reference No. 177828.

Port improvements in a Brazilian city. An appropriation has been authorized by a recent decree for the continuation of port improvements in a city in Brazil. Reference No. 177025.

Aqueduct and waterworks for a city in Panama. The installation of water-

(*Continued on p. 451*)

Demand, Reserve Stocks and Output of Basic Materials Point to Continuation of Activity

Manufactured Products Rather Than Raw Materials Offered Better Resistance to Seasonal Summer Slump

Production capacity at mills manufacturing basic building materials as a class, is evidently not in excess of the consuming power of the construction industry. Steel and glass are possible exceptions, however, since the mill capacity of the former is estimated at 17 per cent in excess of the nation's requirements while in the latter severe foreign competition has affected the American market.

It might be said that the only industries in actual danger of over-expansion are: steel, glass, automotive, agricultural implements, leather, paper and textiles. It is obvious that continually increasing buying power and expansion of demand will absorb excess production in a comparatively few years.

The ability of the basic materials' market to resist a seasonal summer slump is shown in the accompanying charts and tabulations. A favorable situation is also shown compared with this time last year.

Latest reports of the Department of Commerce show the situation as to production, reserve stocks and demand for all materials, as follows: raw materials' output slightly below a year ago; production of manufactured materials, considerably heavier; reserves of raw materials substantially greater than last year; about the same quantity of manufactures on hand; demand, as interpreted by unfilled orders, better than in 1924 in iron, steel and all building materials. Taking four of the most important construction materials, separately, the situation is as follows:

Steel—Mill operations are at 70 to 75 per cent of capacity, against 60 per cent a year ago. Reports on ingot output, to be issued later in the month, will probably show an up-turn as compared with the downward course followed since March of the current year. The drop in unfilled orders is expected to be less severe. Iron production gained one per cent during August compared with the month preceding. Steel buying is most active for automotive requirements, agricultural implements and construction. Awarded contracts for steel structurals are 88 per cent ahead of this time last year.

Lumber—Satisfactory increases were noted in output, shipments and new business in latest reports received by the National Lumber Manufacturers' Association and released Sept. 3.

The following tabulation compares the national lumber movements for the three weeks indicated:

	Week of Aug. 29 Ft. b.m.	Corresponding Week in 1924 Ft. b.m.	Preceding Week in 192- Ft. b.m.
Production	250,164,981	217,874,202	247,677,055
Shipments	245,232,923	230,105,896	243,453,055
New business	258,046,065	219,839,820	241,784,224

The following figures compare the lumber movements for the first thirty-five weeks of 1925 with the same period in 1924:

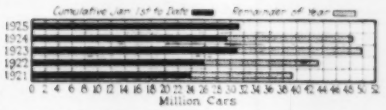
	Production Ft. b.m.	Shipments Ft. b.m.	Orders Ft. b.m.
1925	8,518,993,317	8,412,360,140	8,288,144,407
1924	8,145,554,876	8,099,415,423	7,849,041,171
1925 increase	373,438,441	312,944,717	439,103,236

Brick—There is substantial gain in shipments from yards throughout the country, compared with a year ago. The quantity of unburned brick is also greater, indicating a continuation of active production for the remainder of the season.

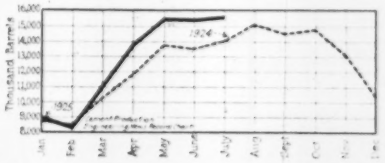
The situation, as reported by the Common Brick Manufacturers' Association of America, is shown by the following tabulation:

	Burned Brick on Hand M	Unburned Brick on Hand M	Brick Moved from Yards During Month M	Orders on Books M
1924 Aug. 1	231,182	86,722	149,622	314,588
1925 Jan. 1	354,477	51,162	118,759	202,906
Feb. 1	279,862	23,951	94,185	201,479
Mar. 1	305,831	34,891	110,790	247,176
Apr. 1	287,800	43,446	170,697	329,673
May 1	281,858	71,266	206,551	339,629
June 1	239,389	67,480	180,851	333,967
July 1	225,401	82,987	173,215	326,226
Aug. 1	227,306	92,267	180,407	292,775

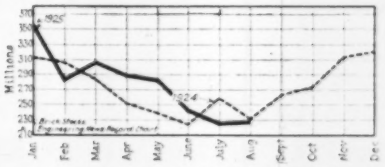
Cement — Production and shipments are at record levels. While reserve mill stocks are dwindling at the rate of approximately 2,000,000 bbl. per month, there is considerably more cement on hand than a year ago.



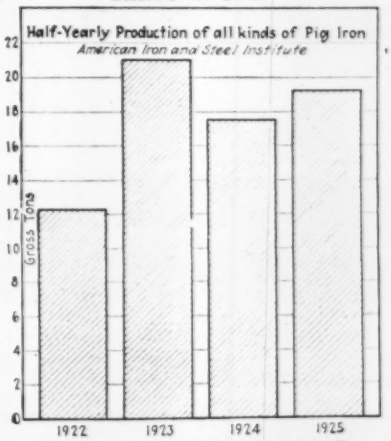
FREIGHT LOADINGS, U. S., AM. RY. ASSOC.



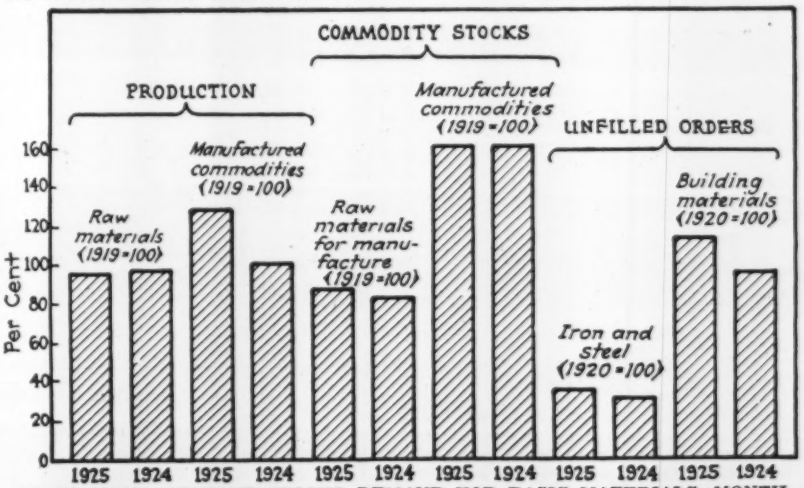
OUTPUT OF U. S. CEMENT MILLS, BUREAU OF MINES



BURNED COMMON BRICK AT YARDS IN U. S.



HOW THIS BAROMETER STOOD JULY 1, 1925



PRODUCTION, RESERVE STOCKS, DEMAND FOR BASIC MATERIALS, MONTH OF JULY—U. S. DEPT. OF COMMERCE FIGURES, E. N.-R. CHART

Foreign Projects of Interest to Americans

(*Concluded from p. 450*)

works and the construction of an aqueduct for a city in Panama is under consideration. Reference No. 178118.

New port improvement projects in Finland. The port committee of the Finnish Government has made a proposal concerning improvements of the ports of Finland to extend through a period of 5 years. The expenditure for the following ports: Helsingfors, (150,000,000 marks); Hango Viborg, Abo, Sordavala (67,500,000 marks); (the mark = $0.025). This construction includes new docks, cranes, trackage, ice breaker, wireless station and warehouses.

Weekly Construction Market

CONSTRUCTION, keeping well ahead of last year to date, appears to have a definite leaning toward commercial, institutional and residential building, as well as public works and utilities. With demand so active it is not surprising to find scattered advances in materials' prices in various sections of the country. The increases, however, are nowhere in excess of the declines. There is a marked upward trend in c.-i. pipe prices in northern New York and in the Denver district. Gravel, stone, lump lime and pine timbers are higher in Chicago. Douglas fir is advancing in the Pacific Northwest, although weak in the Denver district. Considerable fluctuation is reported in prices of reinforcing bars, linseed oil, white lead and rosin sized sheathing. The declines affect steel shapes in the Dallas market, c.-i. pipe in Dallas and Chicago; common brick in New York City; cement, tile, window glass and wire nails in northern New York State. Increase in demand for general labor has developed in Seattle during the past week, according to telegraphic reports from that section. Production at fir lumber mills in the Northwest is at a high point with demand warranting and prospects appear favorable for a fall business which should carry through well into the winter. Iron and steel, accepted barometers of trade, reveal the following market conditions: Pig iron holds firm at about 50c. per ton above a month ago; most of the buying is in small tonnage lots. Iron and steel scrap prices are advancing rapidly. Coke is up 25 to 75c. per ton, compared with the last week in August. Plates and blue annealed sheets are possibly the slowest of the principal steel items. Plates are $1.80@$1.90 per 100 lb., Pittsburgh, with shapes, $1.80@$2 and reinforcing bars $1.90@$2 per 100 lb. at mills. Compared with a week ago, this shows slight weakness in shapes, with the other principal hot-rolled items unchanged.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, 100 lb	$3.34	$3.90	—$4.00	$3.10	$3.35	$3.07½	$3.30	$3.35	$4.25
Structural rivets, 100 lb	4.50	4.45	4.75	3.50	3.75	4.65	5.00	3.75	6.00
Reinforcing bars, ¾ in. up, 100 lb	3.24	3.40	—2.80	3.00	3.25	3.62½	3.35	3.25	2.30
Steel pipe, black, 3½ to 6 in. lap, discount	48%	58%	53.6%	51%	54.25%	36%	39.2@51%	50%	59.49
Cast-iron pipe, 6 in. and over, ton	50.60@51.60	44.80	—54.00	—49.20@50.20	53.00	+63.00	52.00	53.00	55.00
Concreting Material									
Cement without bags, bbl	2.50@2.60	2.25	2.05	2.20	2.42	2.84	2.31	2.65	1.80
Gravel, ¾ in., cu.yd	1.75	2.20	2.38	+2.00@2.20	1.65	1.90	2.15	1.50	1.25
Sand, cu.yd	1.00	1.65	2.00	1.40	1.25	1.00	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd	1.85	2.20	2.83	+2.00@2.20	1.75	2.50	2.15	3.00	1.90
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft	59.00	34.00	58.50	45.00	38.75	—33.75	27.00	24.00	60.00
Lime, finishing, hydrated, ton	18.20	22.50	18.00	20.00	25.50	24.00	22.00	24.00	21.00
Lime, common, lump, per bbl	2.25@2.75	1.30	1.85	+1.45	1.35	2.70	1.60	2.80	9.50
Common brick, delivered, 1,000	—17.50@18.00	10.50	11.60	12.00	13.50	12.00	15.50	15.00	17.50
Hollow building tile, 4x12x12, per block	Not used	.0893	.10	.075	.....	.085	.....	.10	.12
Hollow partition tile 4x12x12, per block	.1162	.0893	.10	.075	.07	.085	.108	.10	.10
Linseed oil, raw, 5 bbl. lots, gal	1.08	+1.17	1.13	—1.02	—1.12	+1.25	1.15	1.12	1.25
Common Labor									
Common labor, union, hour	.55@.75	.30	.....	.87½	.....	.50@.55	.55	.62½	.....
Common labor, non-union, hour	.....	.25	.30@.50	.82½	.50@.55	.35@.50	.50	.50	.25@.35

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime, in 280-lb. bbl. net, and hydrated lime f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Labor—Concrete laborers' rate, 93¾c.; building laborers, 75c.; excavating laborers, 55c. per hr.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber, sand, gravel and stone delivered on job.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.70 for Kelly Island and $1.60 for Sheboygan. Common labor not organized.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of September 3, the next on October 1.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers.

Montreal quotes on pine lumber. Sand, stone, gravel and lump lime per ton. Stone and tile are delivered; sand, gravel, lime and cement on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at par). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 3½-in., $59.49.

Business Briefs

Call money quoted at 4@5½ per cent, Sept. 8: year ago, 2 per cent.

Time loans: short terms, 4½ per cent; longer periods, 4¾ per cent.

Commercial paper: best names, 4¾ per cent; other names, 4½ per cent.

On September 1, 1925

E. N.-R. Construction Cost Index Number 202.10

E. N.-R. Construction Volume Index Number 266

For Explanation and Details of Indexes Since 1913 See the First Issue of Every Month